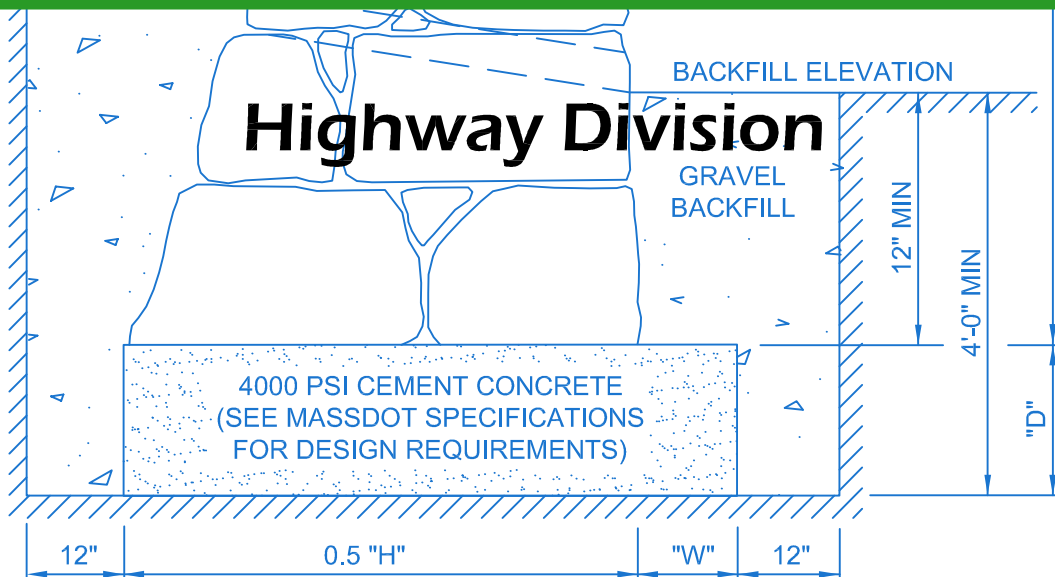


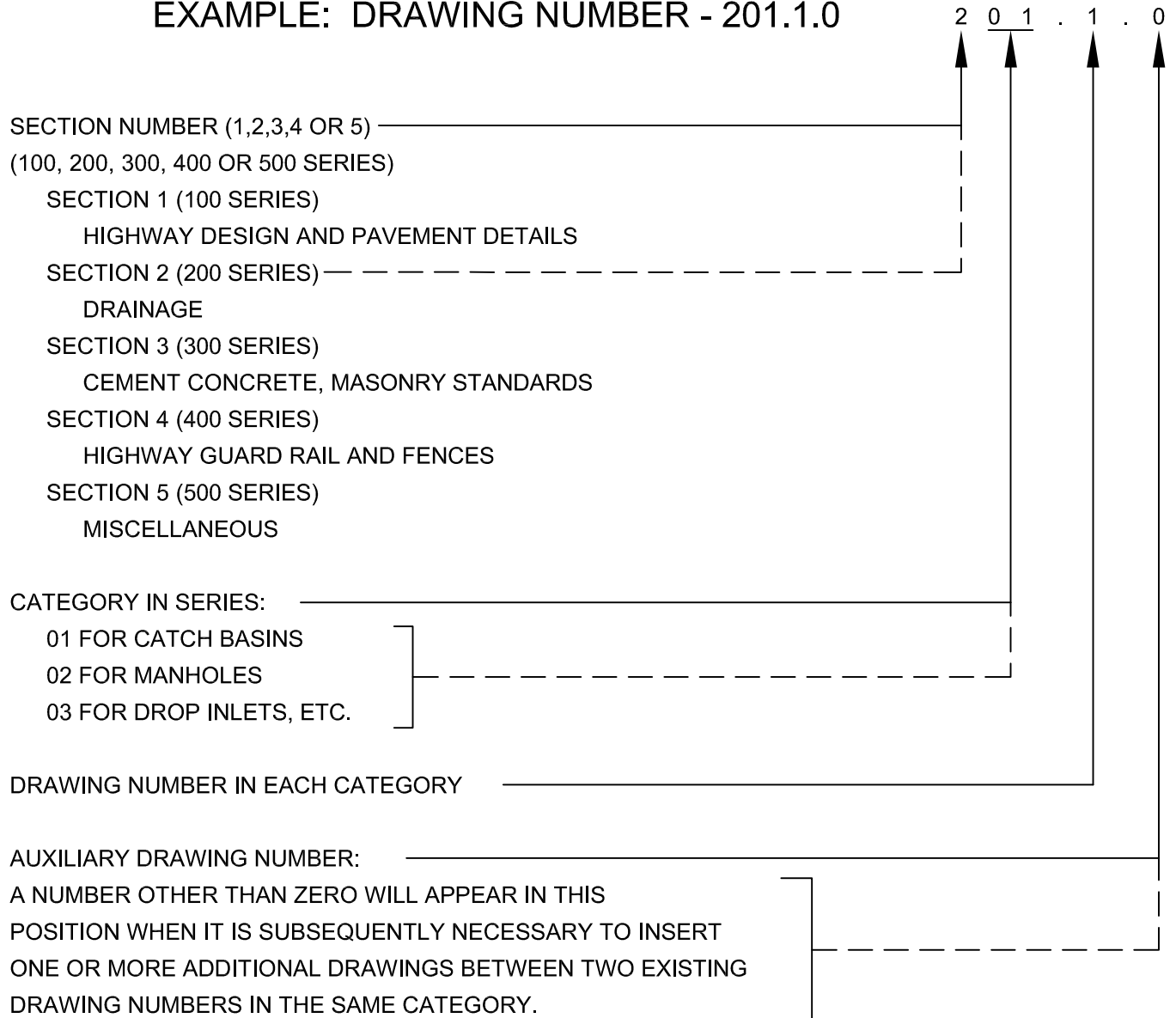
# Massachusetts Department of Transportation

## Construction Standard Details



OCTOBER 2017

## EXAMPLE: DRAWING NUMBER - 201.1.0



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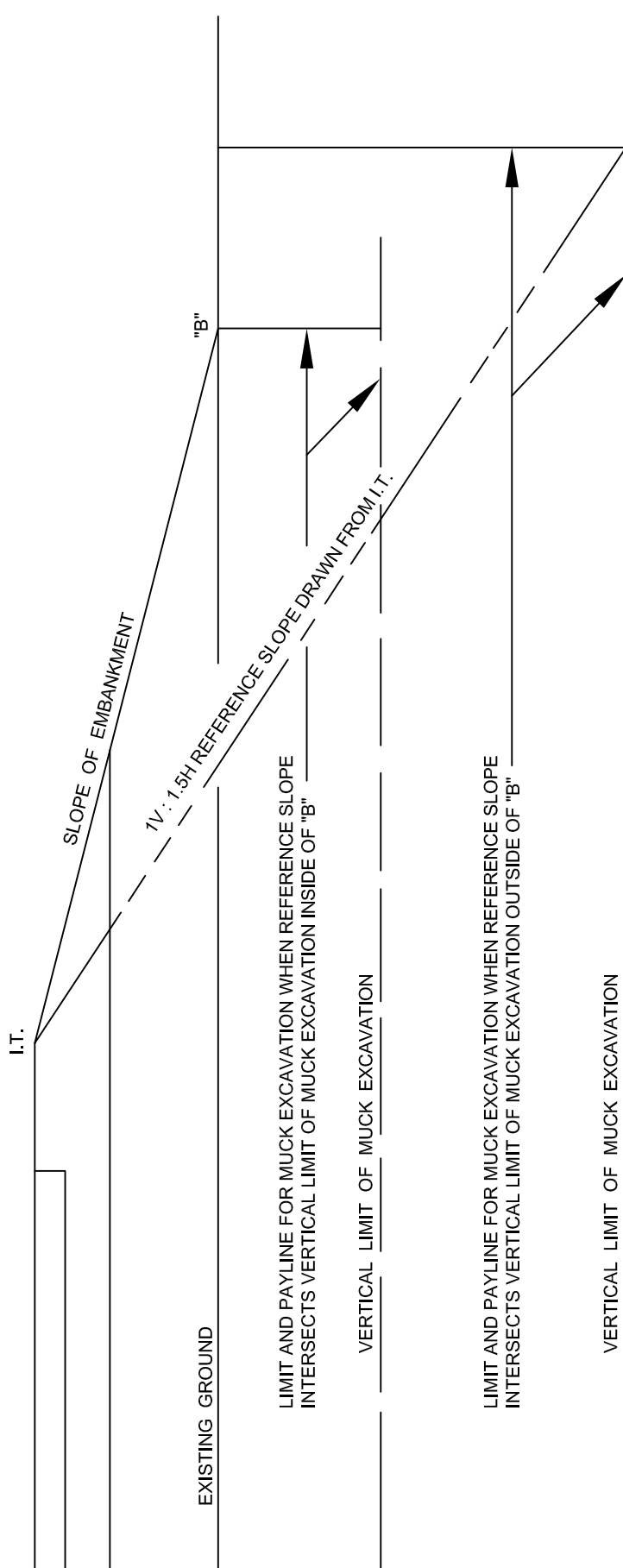
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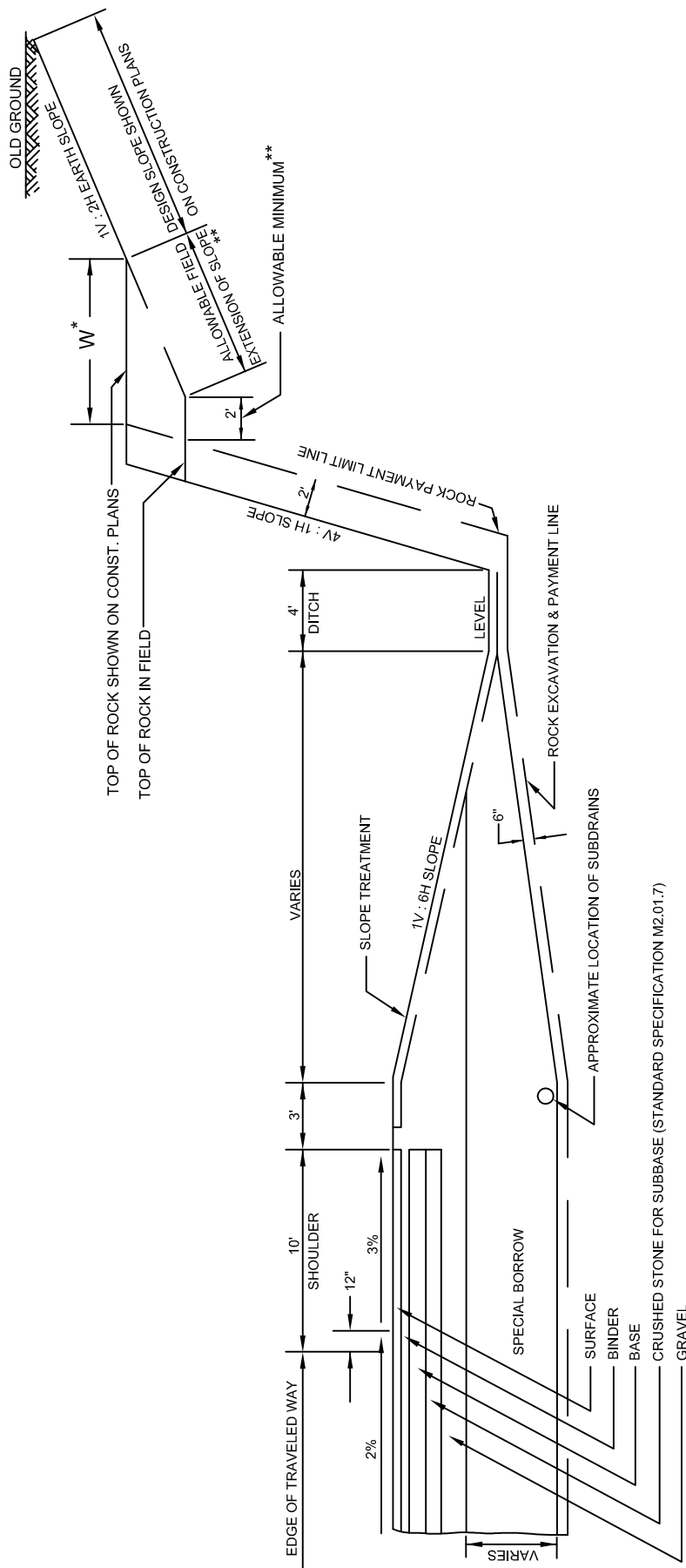
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# NOTES:

1. "B" - INTERSECTION OF EXISTING GROUND AND SLOPE OF EMBANKMENT
2. THE ABOVE METHOD MAY ALSO BE USED TO DETERMINE THE LIMIT FOR EXCAVATION OF OTHER UNSUITABLE MATERIALS
3. I.T. - INTERSECTION OF TANGENT



\* **DESIGN** { W=12' FOR ROCK CUTS OF 20' OR LESS  
W=17' FOR ROCK CUTS 25' OR MORE  
W-VARIES 12' - 17' FOR ROCK CUTS BETWEEN 20' - 25'; DETERMINE PROPORTIONATELY

\*\* THE EXTENSION OF THE DESIGN SLOPE IN THE FIELD IS PERMISSIBLE WITHIN THE LIMITS SHOWN (2' SHELF ON TOP OF THE ROCK), WHEN THE HEIGHT OF THE ROCK CUT IN THE FIELD IS LESS THAN THAT SHOWN ON THE CONSTRUCTION PLANS

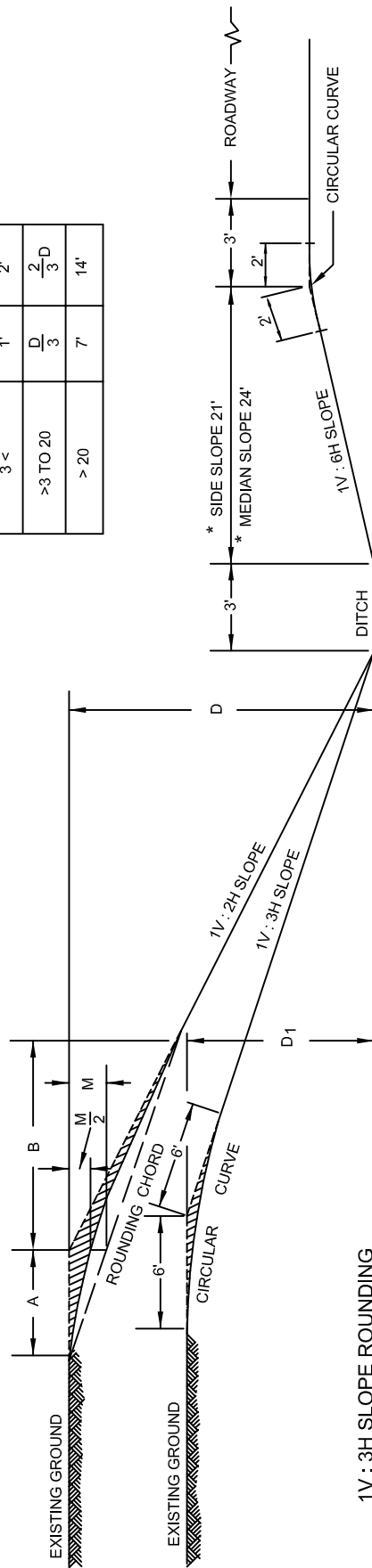
NOTES:  
1. ONLY ROCK ACTUALLY REMOVED IS PAYABLE. NO PAYMENT WILL BE MADE BEYOND THE ROCK PAYMENT LINE

# METHOD OF ROUNDING SLOPES CUT AND FILL SLOPES

## METHOD OF ROUNDING CUT SLOPES

ROUNDING TABLE FOR 1V : 2H SLOPE

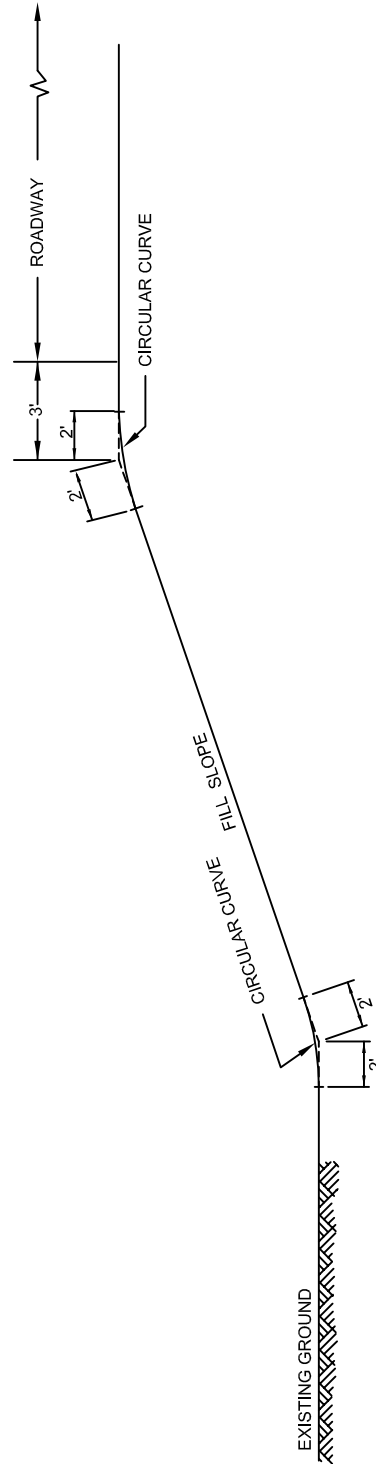
D FEET	A	B
3 <	1'	2'
>3 TO 20	$\frac{D}{3}$	$\frac{2}{3}D$
> 20	7'	14'



### 1V : 3H SLOPE ROUNDING

1. WHEN "D1" IS 2' OR MORE ROUND AS SHOWN IN TABLE ABOVE.
2. WHEN "D1" IS LESS THAN 2' ROUND FULL LENGTH OF SLOPE.

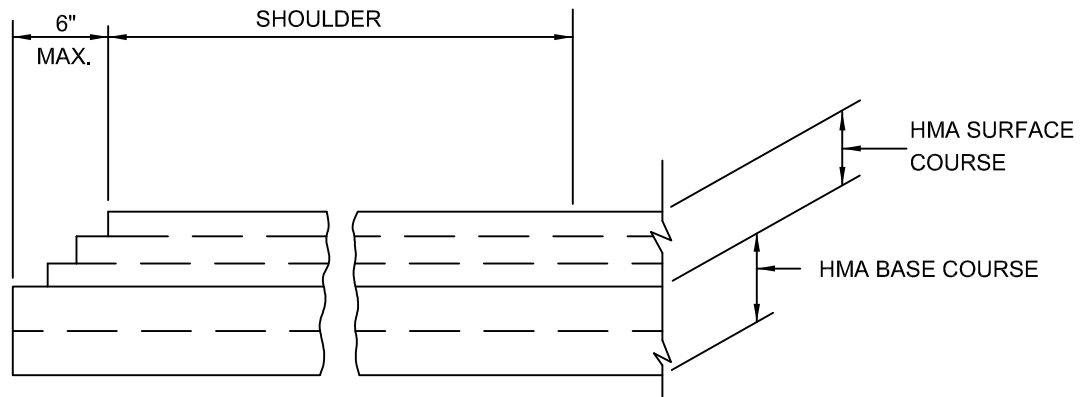
## METHOD OF ROUNDING FILL SLOPES



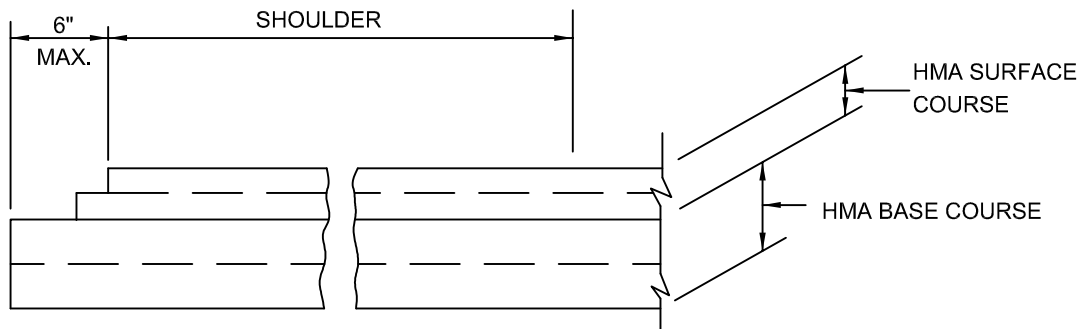
\* USE SLOPE LENGTHS FOR LIMITED ACCESS OR HIGH SPEED ROADWAYS.

NOTE:

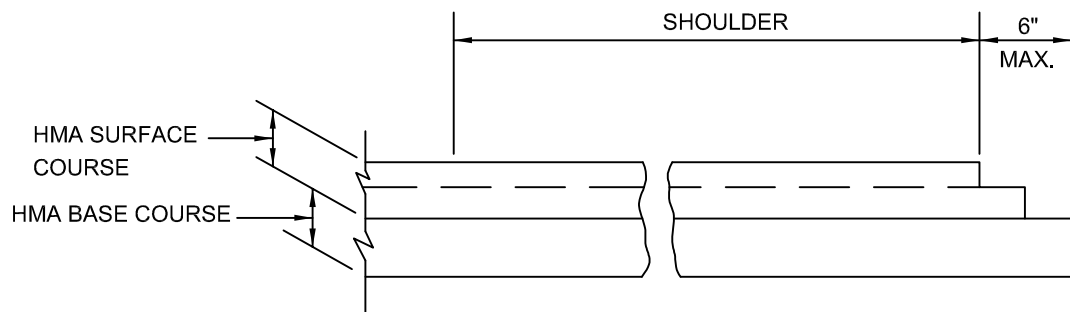
1. THE DIMENSIONS SHOWN FOR ROUNDING CUT AND FILL SLOPES ARE APPROXIMATE; THEY ARE TO BE USED AS GUIDES.



3 - LAYERED SURFACE AND 2 - LAYERED BASE COURSE



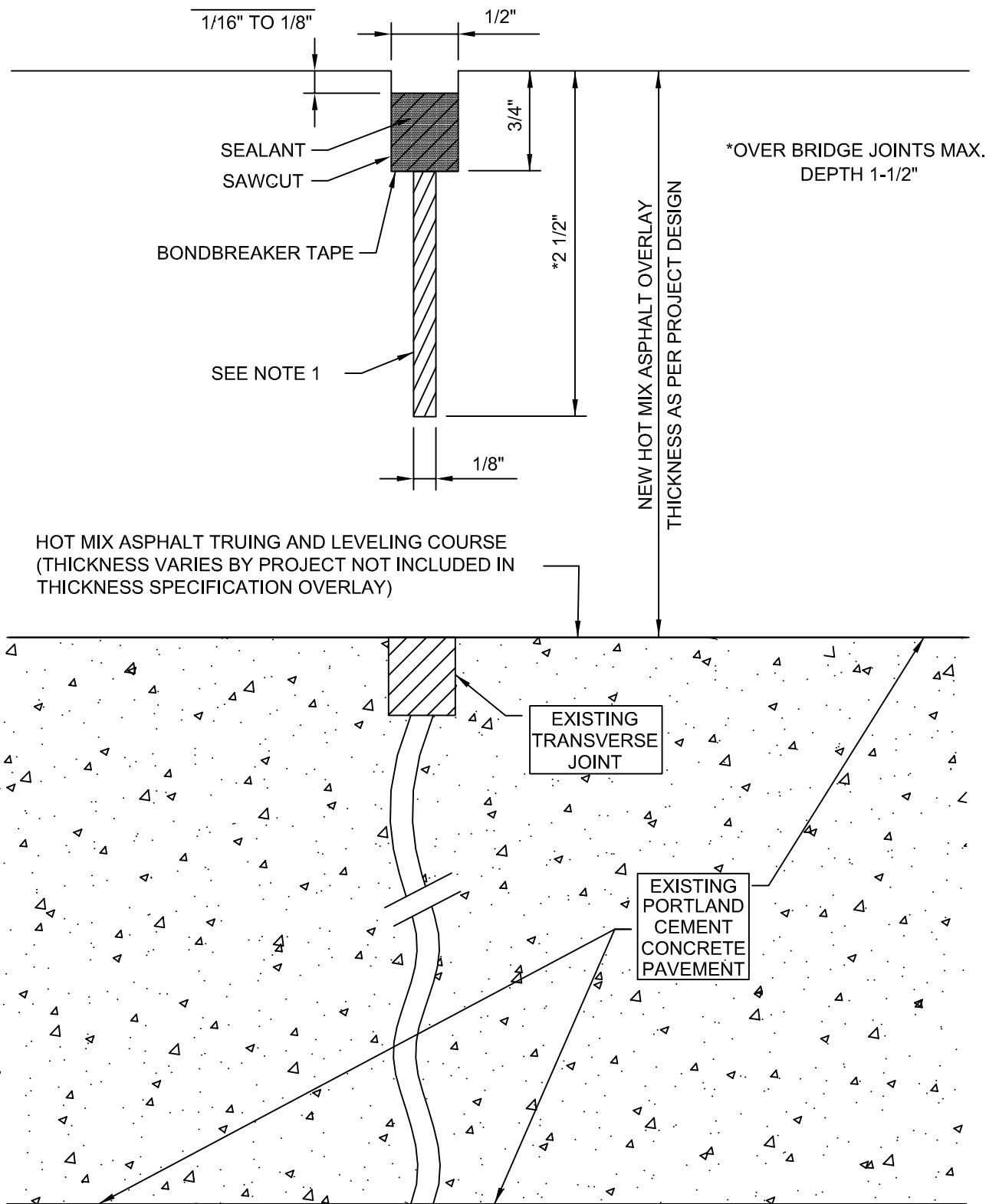
2 - LAYERED SURFACE AND 2 - LAYERED BASE COURSE



2 - LAYERED SURFACE AND 1 - LAYER BASE COURSE

NOTES:

1. ONLY APPLICABLE STEPPING METHODS OF THIS DRAWING ARE TO BE SHOWN IN THE TYPICAL SECTION OF THE CONSTRUCTION PLANS. THIS SHALL BE SHOWN AS A SEPARATE DETAIL AND NOT INCLUDED ON EACH SECTION.
2. STEPPING SHALL NOT BE SHOWN ON THE CROSS SECTION TEMPLATES.
3. ADDITIONAL MATERIAL REQUIRED FOR STEPPING SHALL BE INCLUDED IN ESTIMATED QUANTITIES.



**NOTES:**

1. WHEN THE TOTAL THICKNESS OF HOT MIX ASPHALT OVER THE EXISTING JOINT EXCEEDS 4-3/8", A 1/8" SAWCUT SHALL BE INCLUDED IN THE JOINT AS SHOWN TO A MINIMUM DEPTH OF 2-1/2".
2. PRIOR TO PLACING THE OVERLAY, ALL JOINTS SHALL BE LOCATED AND REFERENCED.



SAW CUT  
SEE E 104.1.1

HMA WEARING COURSES

HMA BINDER COURSES

HMA BASE COURSES

GRAVEL

CONCRETE DECK SLAB

APPROACH SLAB

EXPANSION BEARING

ABUTMENT

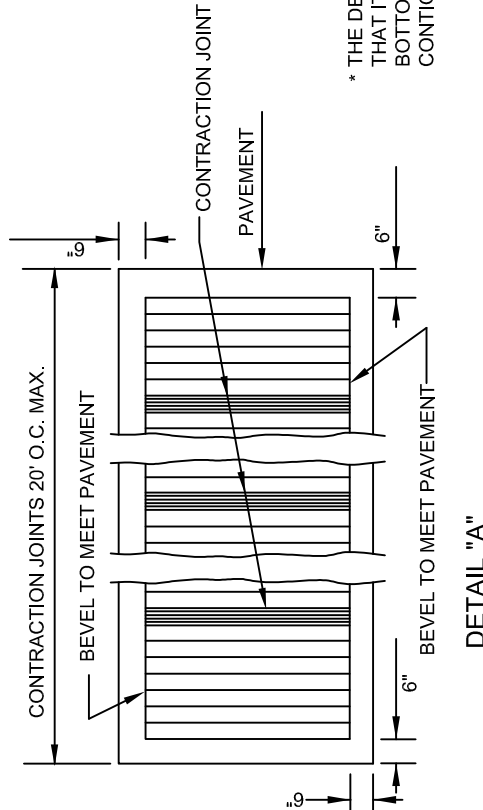
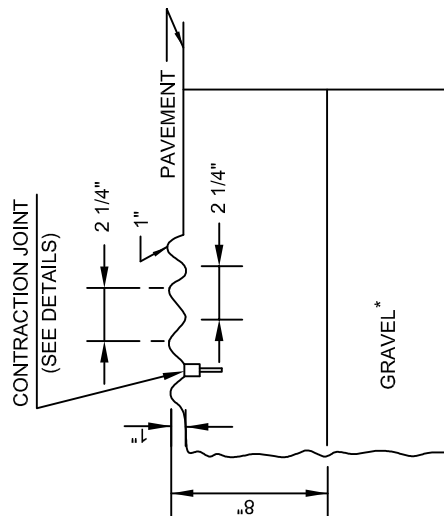
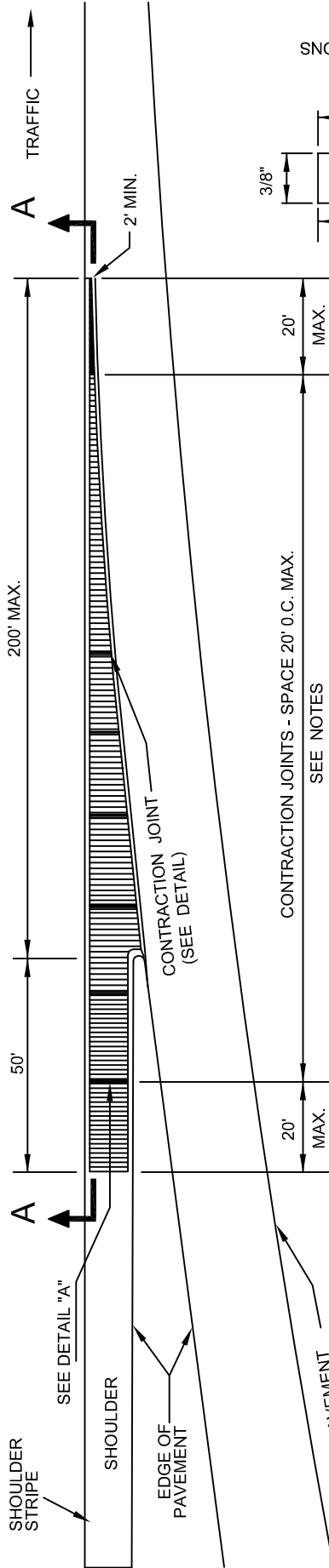
NOTES:

1. BEFORE SAW-CUTTING THE TRANSVERSE JOINT THE CONTRACTOR SHALL LOCATE THE END OF THE BRIDGE DECK. SAW-CUTTING MUST TAKE INTO ACCOUNT THE SKEW ANGLE OF THE BRIDGE.
2. ONLY EXPANSION JOINTS SHALL BE SAW-CUT AND SEALED.
3. ONLY REQUIRED WITH A CONTINUOUS BITUMINOUS CONCRETE SURFACE FROM ROADWAY TO BRIDGE.

# **SCORED CEMENT CONCRETE PAVEMENT RAMPS**

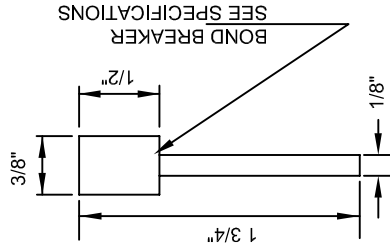
DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 105.2.0**



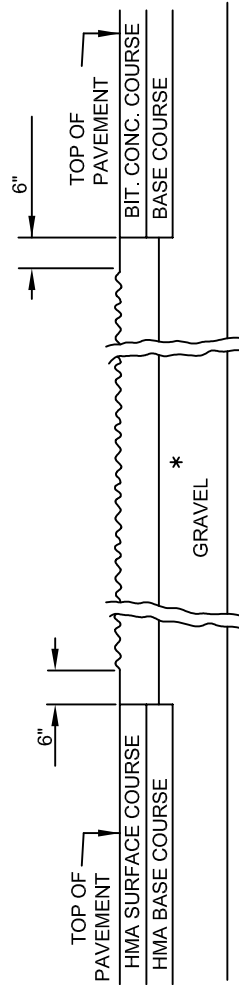
\* THE DEPTH OF THE GRAVEL IS TO BE SUCH THAT ITS BOTTOM LINE MEETS THE BOTTOM OF THE GRAVEL LINE OF THE CONTIGUOUS PAVEMENT.

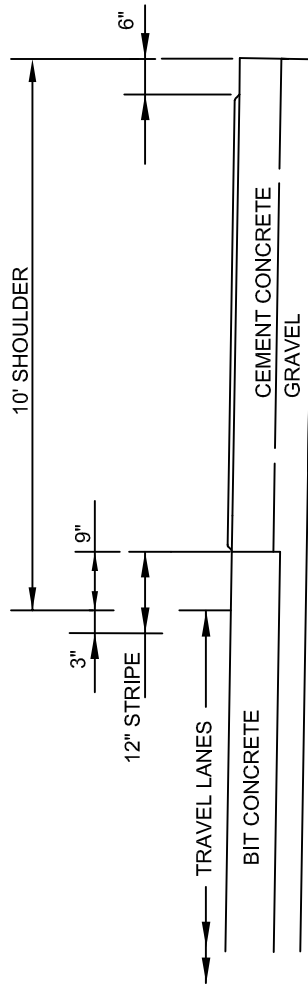
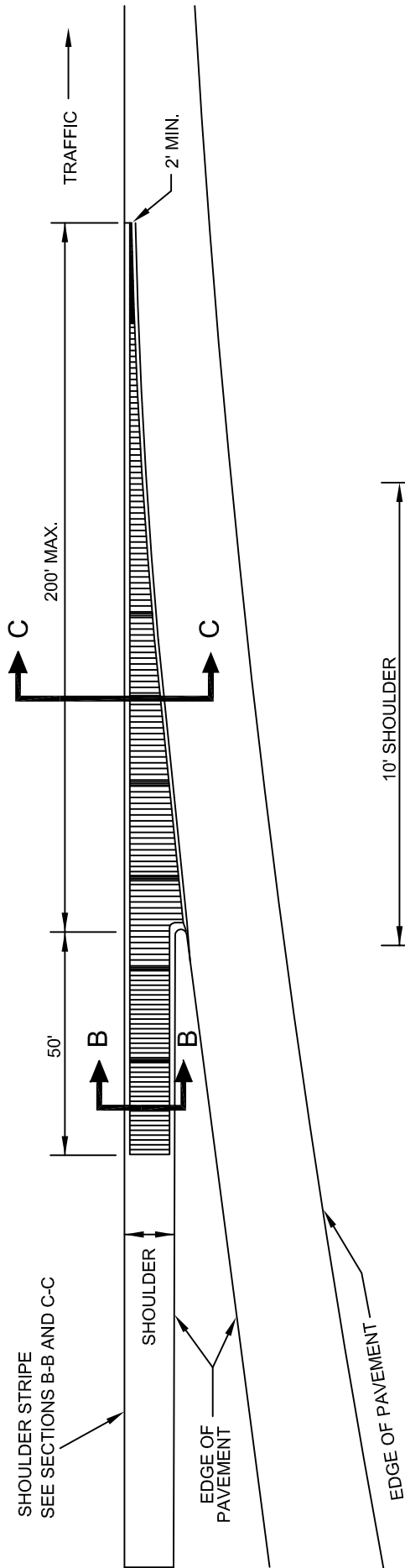
CONTRACTION JOINT DETAIL



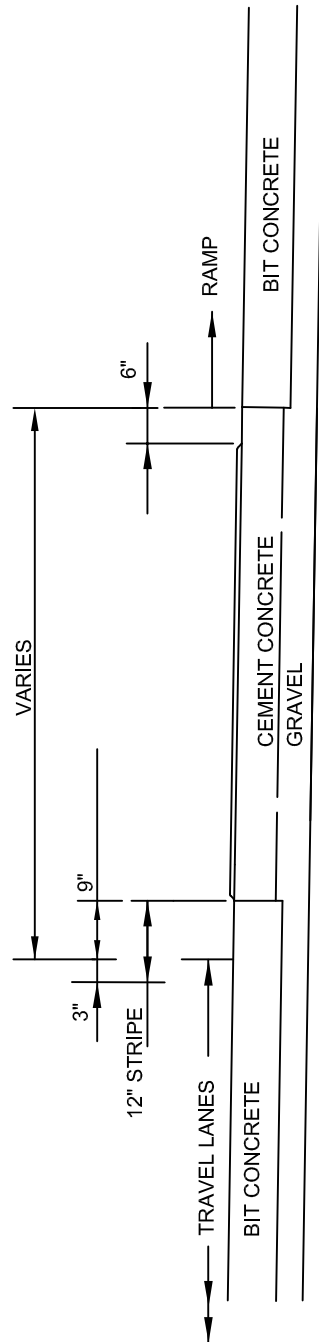
## **NOTES:**

1. CONTRACTION JOINTS ARE TO BE SPACED AT A MAXIMUM OF 20' APART.
2. THE JOINTS ARE TO BE SAWED AND LOCATED IN THE DEPRESSIONS OF THE CORRUGATIONS. SEE DETAIL OF CORRUGATIONS.
3. END OF CORRUGATED RIDGES TO BE BEVELED. FOR DESCRIPTION OF MATERIAL AND CONSTRUCTION METHODS SEE STANDARD SPECIFICATIONS AND SPECIAL PROVISIONS.
4. SCORED CEMENT CONCRETE TO BE 5000 psi. SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS.
5. TROUGH FLUSH WITH OR ABOVE ADJACENT PAVEMENT FOR DRAINAGE.





SECTION B - B

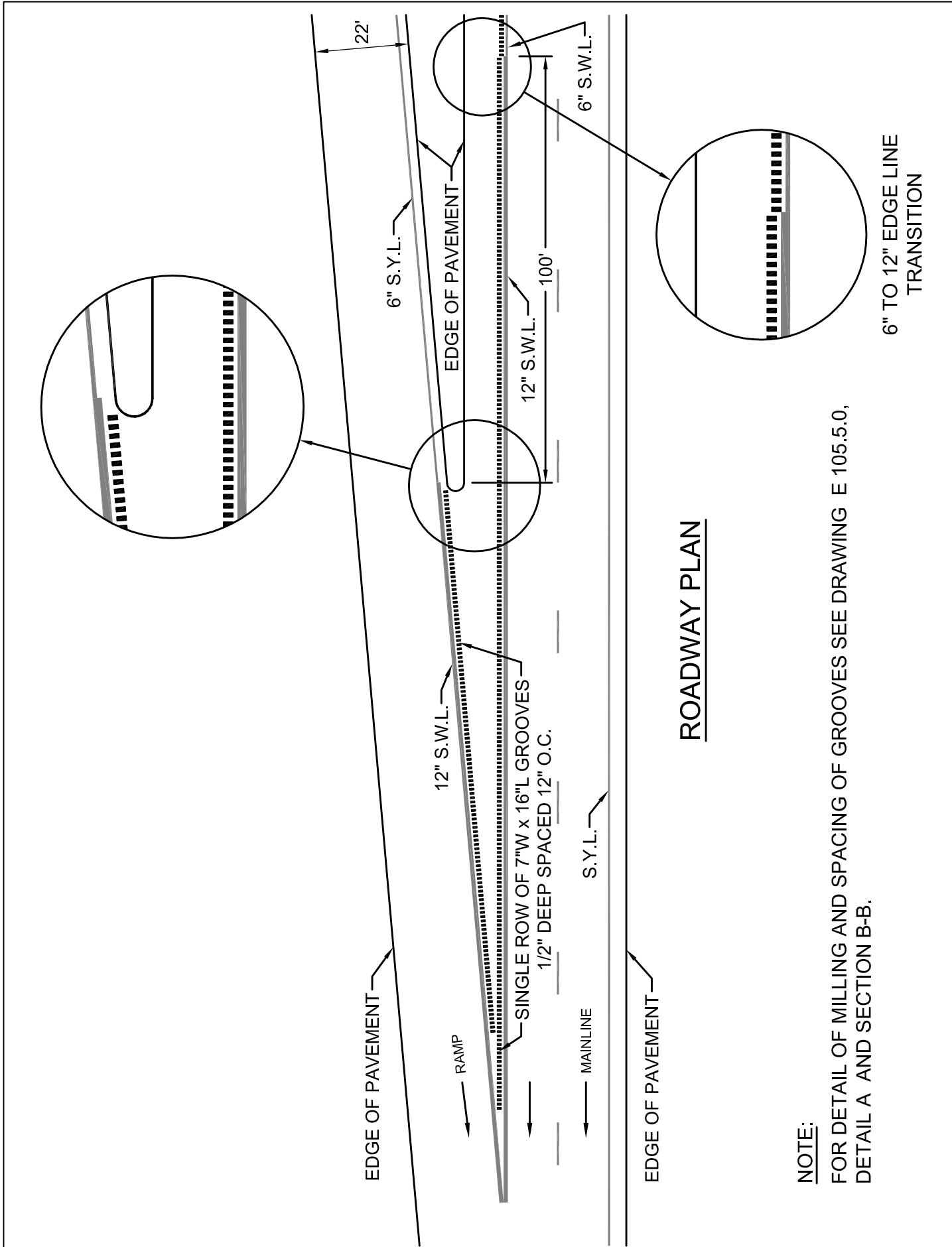


SECTION C - C

# **FREEWAY ENTRANCE RAMP DETAIL RUMBLE STRIP INSTALLATION AT GORE AREAS**

DATE OF ISSUE  
OCTOBER 2017

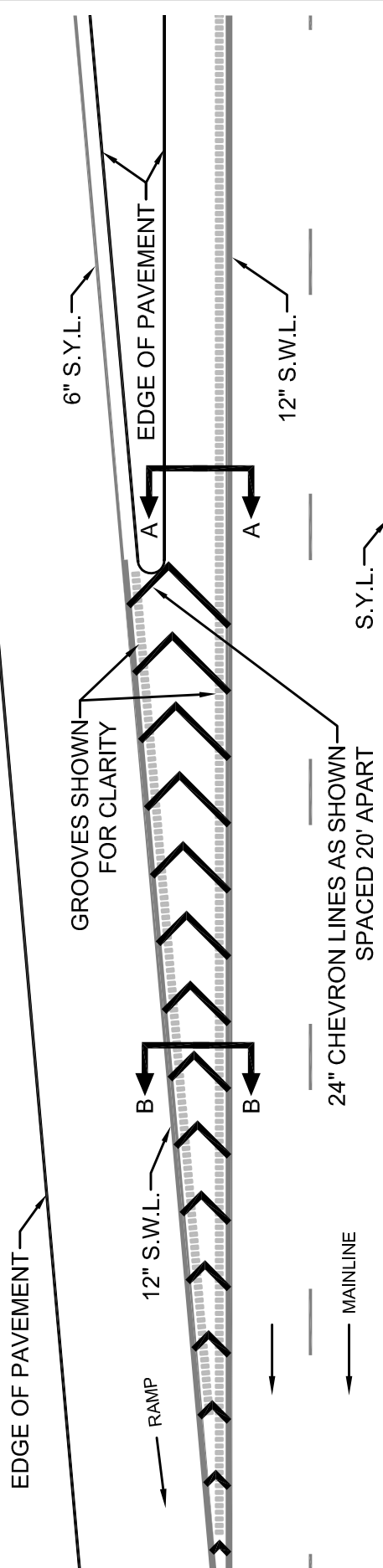
DRAWING NUMBER  
**E 105.3.2**



# **FREEWAY ENTRANCE RAMP DETAIL PAVEMENT MARKING INSTALLATION AT GORE AREAS**

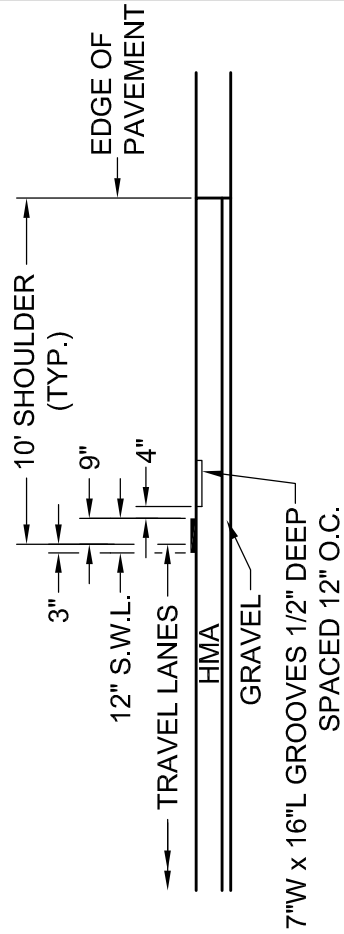
DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 105.3.3**

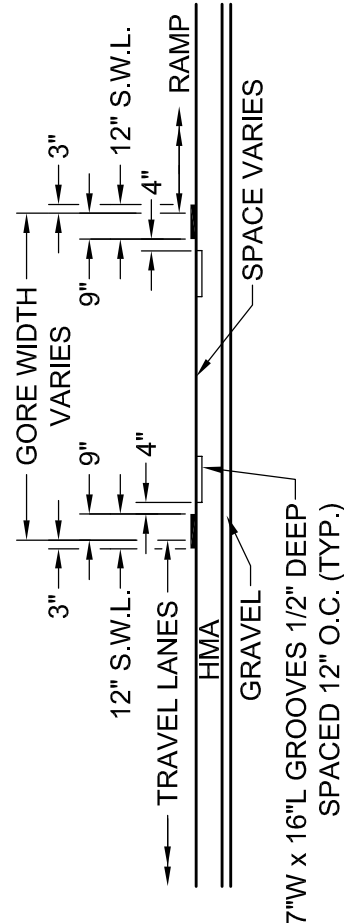


## **ROADWAY PLAN**

EDGE OF PAVEMENT



## **SECTION A-A**



## **SECTION B-B**

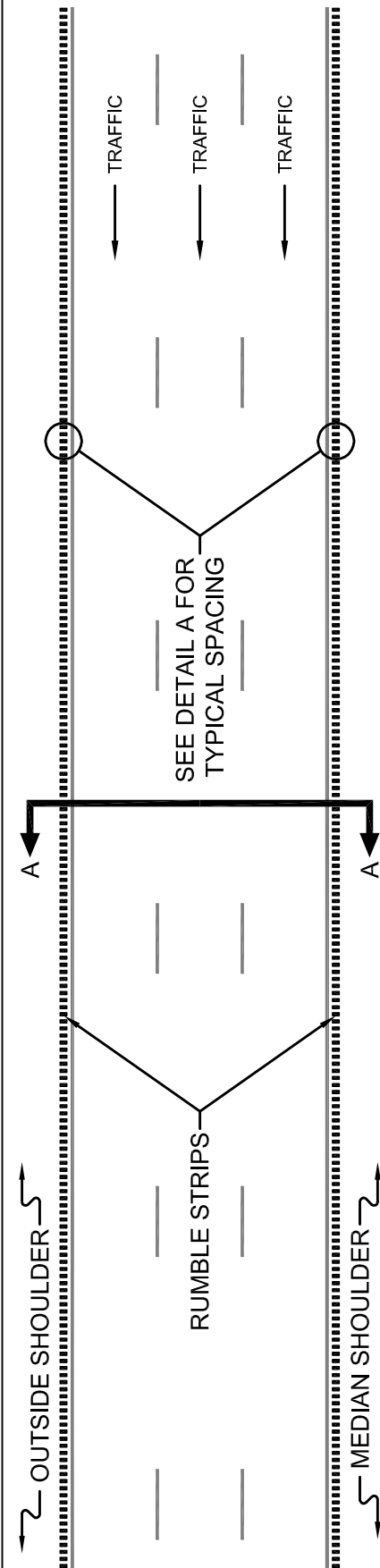
### **NOTE:**

SEE DRAWING E 105.3.2 FOR TRANSITION FROM 6" TO 12" LINES  
AND OTHER INFORMATION.

# RUMBLE STRIP INSTALLATION DETAILS BICYCLES PROHIBITED

DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 105.5.0**



OUTSIDE SHOULDER

TRAVEL LANES

MEDIAN SHOULDER

OUTSIDE SHOULDER

EDGE LINE

16"

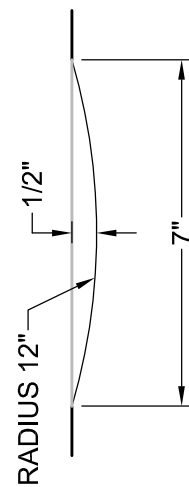
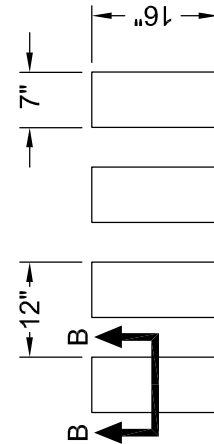
4"

HMA

GRAVEL

MILLED SURFACE FOR RUMBLE STRIP

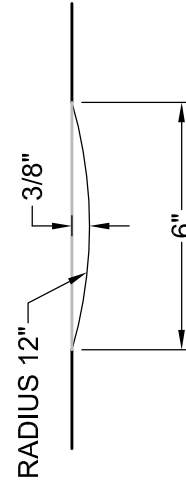
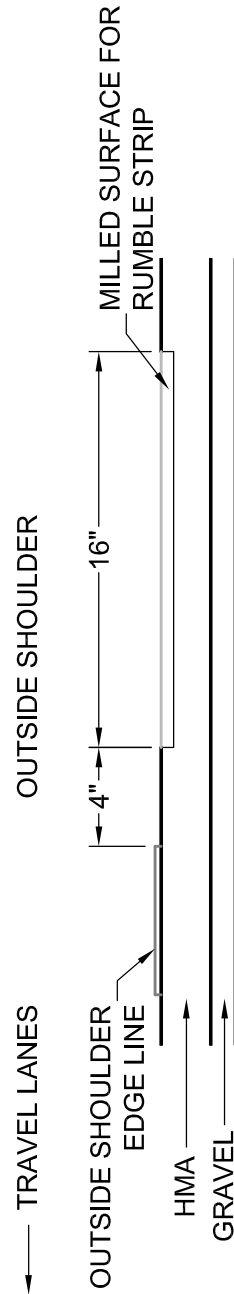
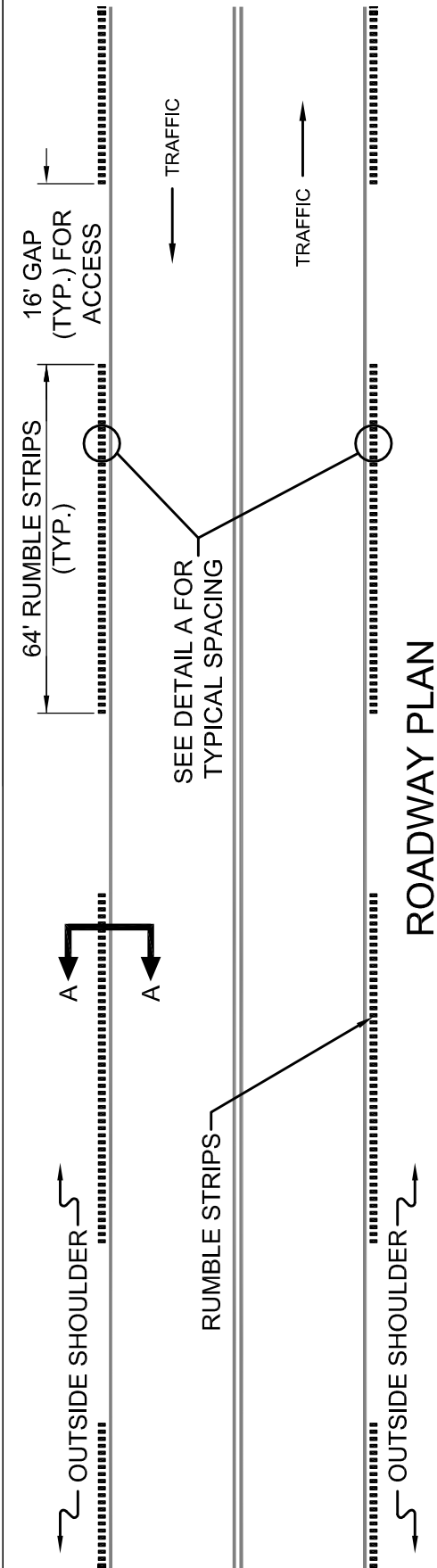
## SECTION A-A ROADWAY



NOTES FOR RUMBLE STRIPS:

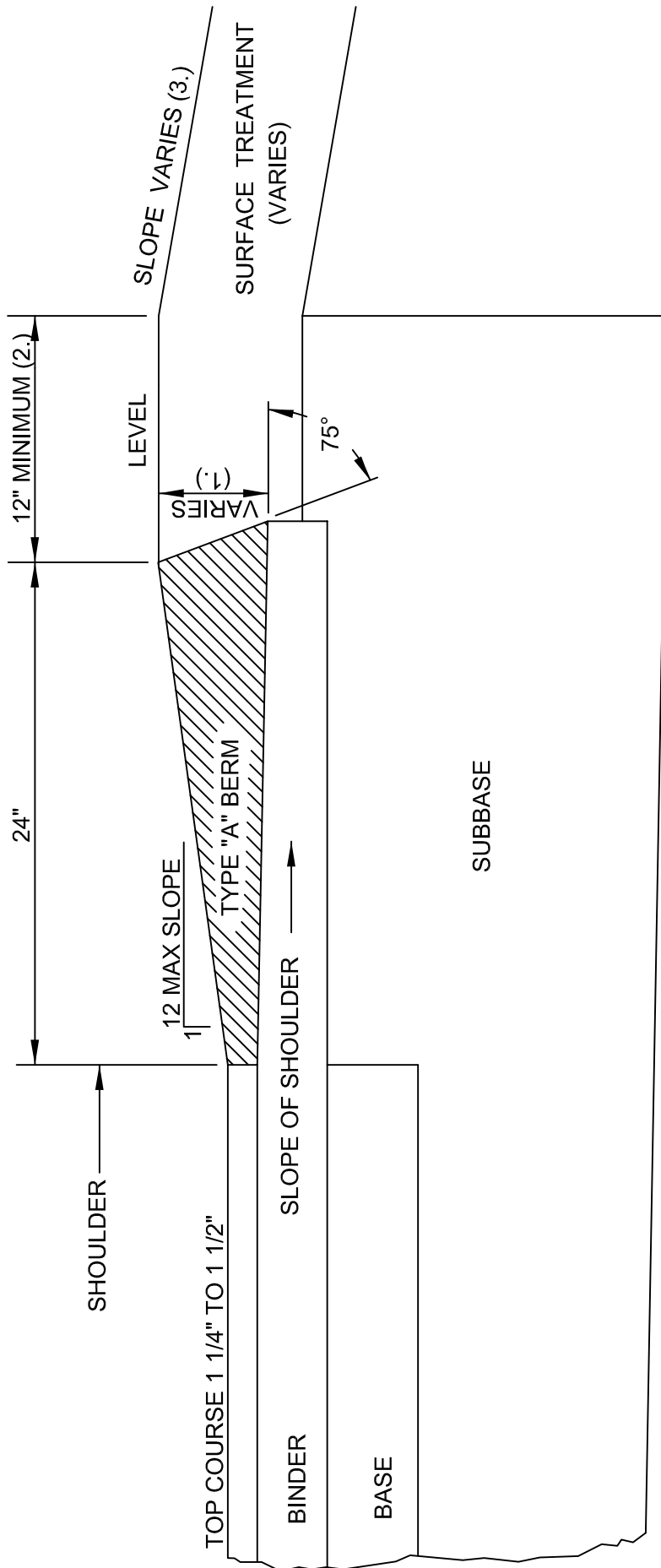
1. NOT TO BE INSTALLED ON SHOULDERS LESS THAN 2' WIDE.
2. NOT TO BE INSTALLED ON BRIDGE DECKS.

# RUMBLE STRIP INSTALLATION DETAILS BICYCLES PERMITTED



NOTES FOR RUMBLE STRIPS:

1. NOT TO BE INSTALLED ON SHOULDERS LESS THAN 8' WIDE.
2. NOT TO BE INSTALLED ON BRIDGE DECKS.

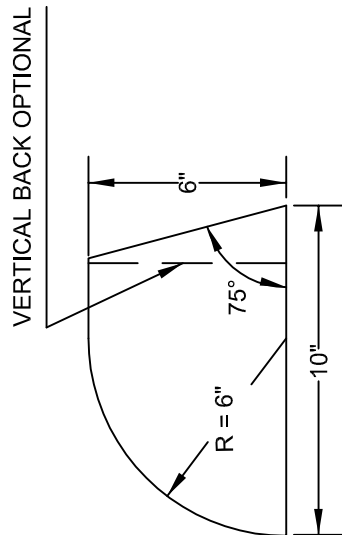


NOTE:

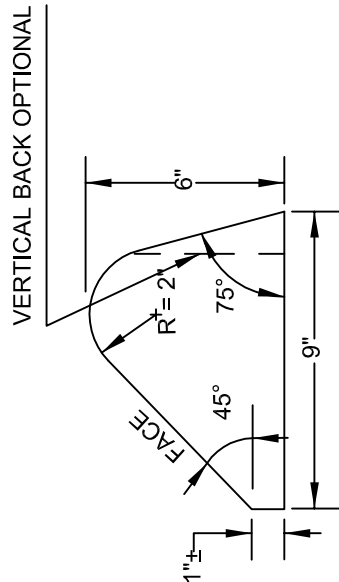
FOR MODIFIED BERM THE SLOPE REMAINS CONSTANT AT 1 (V) TO 12 (H)

1. THIS DIMENSION VARIES WITH THE THICKNESS OF THE TOP COURSE AND SLOPE OF BINDER
2. SEE E 401.1.1 FOR TYPICAL SECTION AT GUARDRAIL LOCATIONS
3. SEE TYPICAL SECTIONS FOR PROJECT

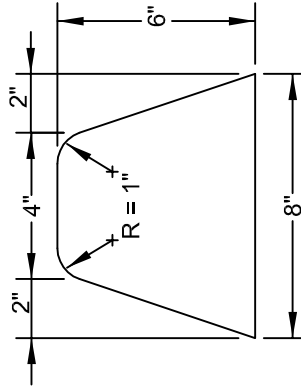




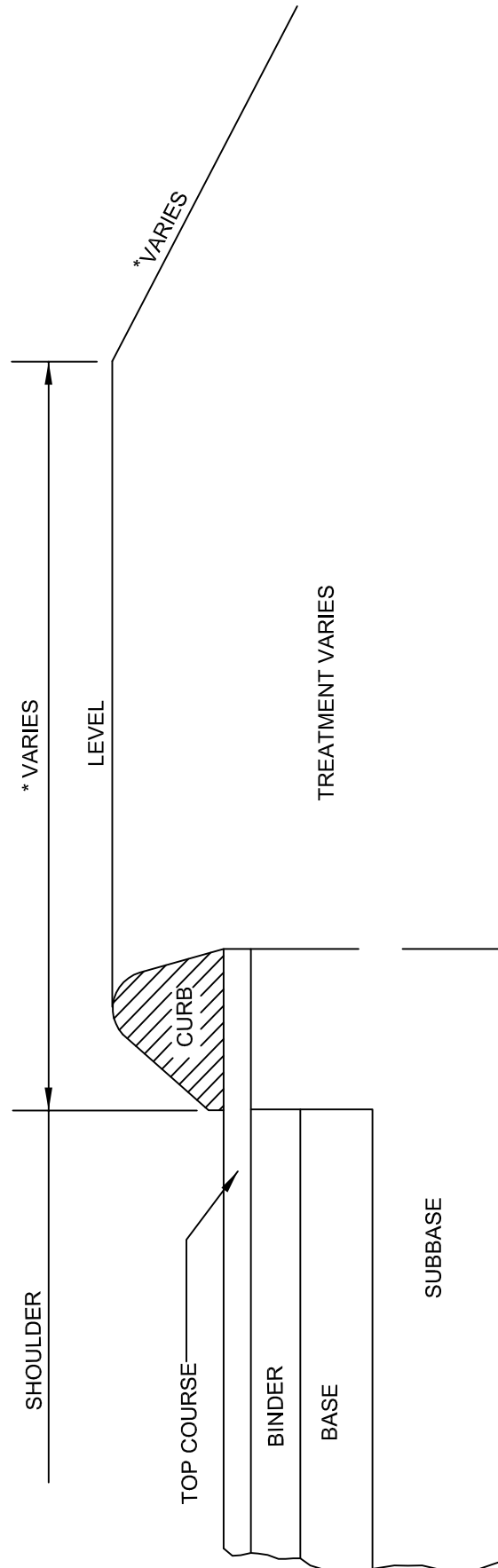
TYPE - 1



TYPE - 2

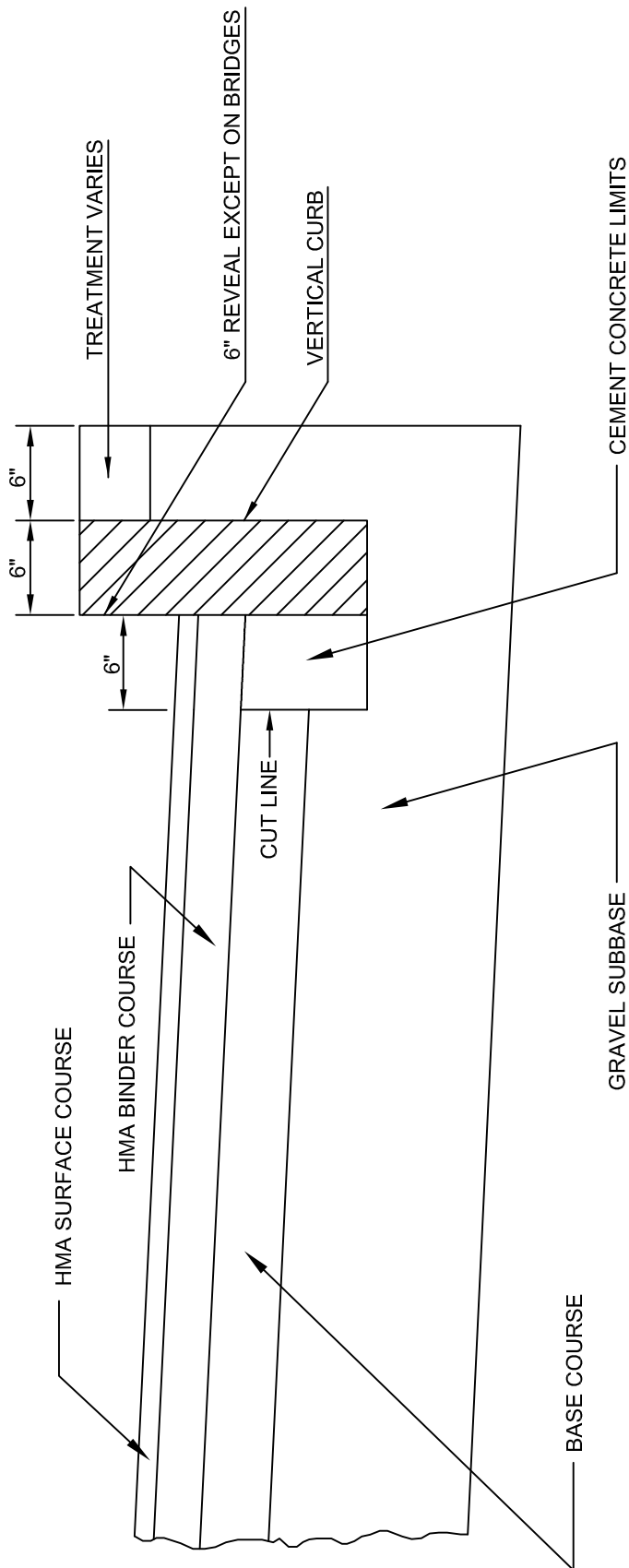


TYPE - 3



METHOD OF SETTING-TYPICAL FOR ALL TYPES

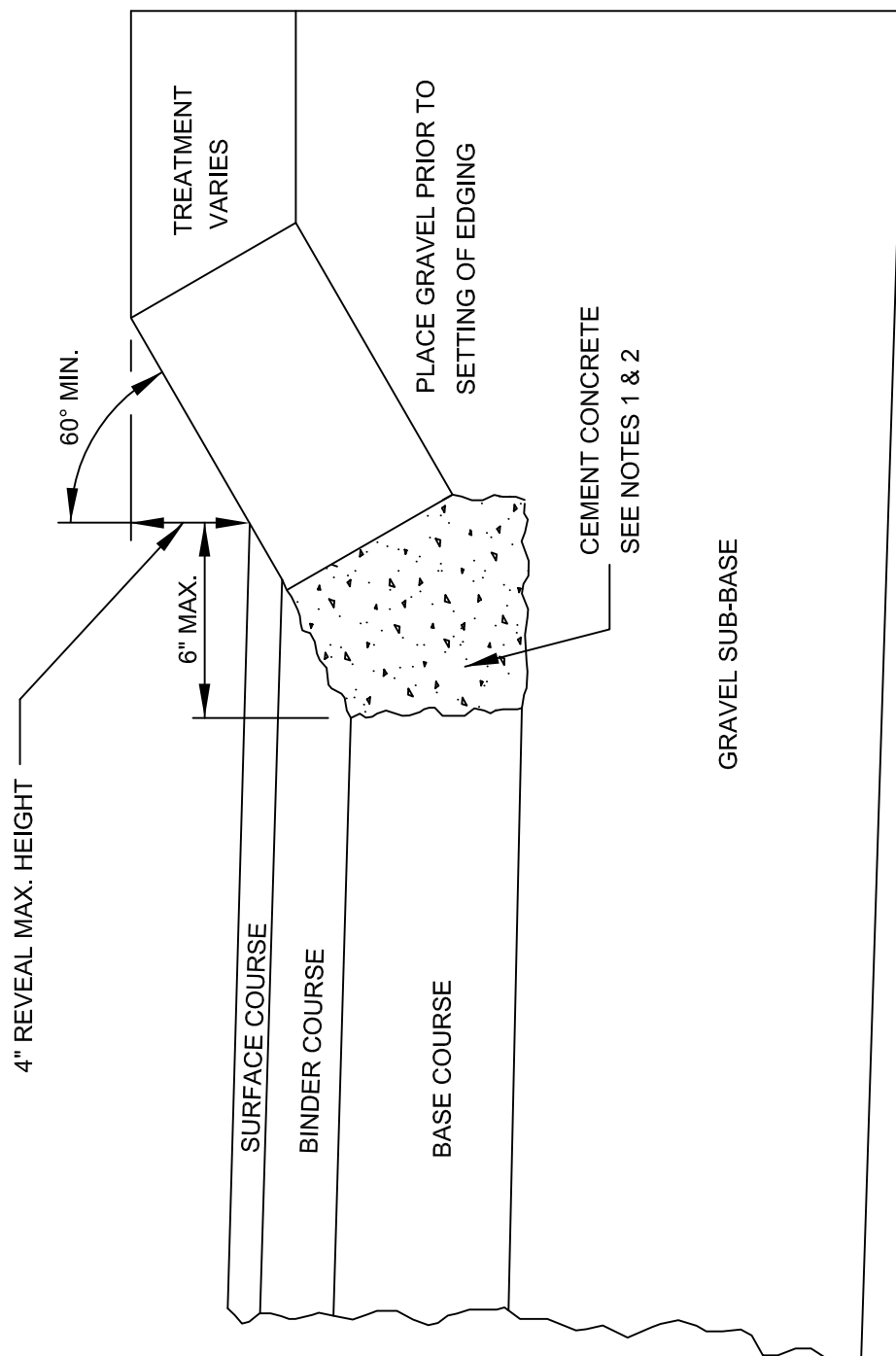
\* SEE TYPICAL SECTIONS FOR PROJECT.



NOTES:

1. THIS PROCEDURE IS APPLICABLE ONLY IF CURB IS TO BE SET AFTER BASE COURSE IS IN PLACE PRIOR TO BINDER AND TOP PLACEMENT.
2. CUT NEAT LINE 6" FROM CURB LINE AND REMOVE BASE AND GRAVEL. REPLACE WITH CEMENT CONCRETE.
3. ANY DESIGNATED CEMENT CONCRETE THAT IS ACCEPTABLE UNDER SECTION M4 OF THE STANDARD SPECIFICATIONS MAY BE USED; ALL TEST REQUIREMENTS ARE WAIVED. HOT MIX ASPHALT SHALL NOT TO BE USED AS A SUBSTITUTE.

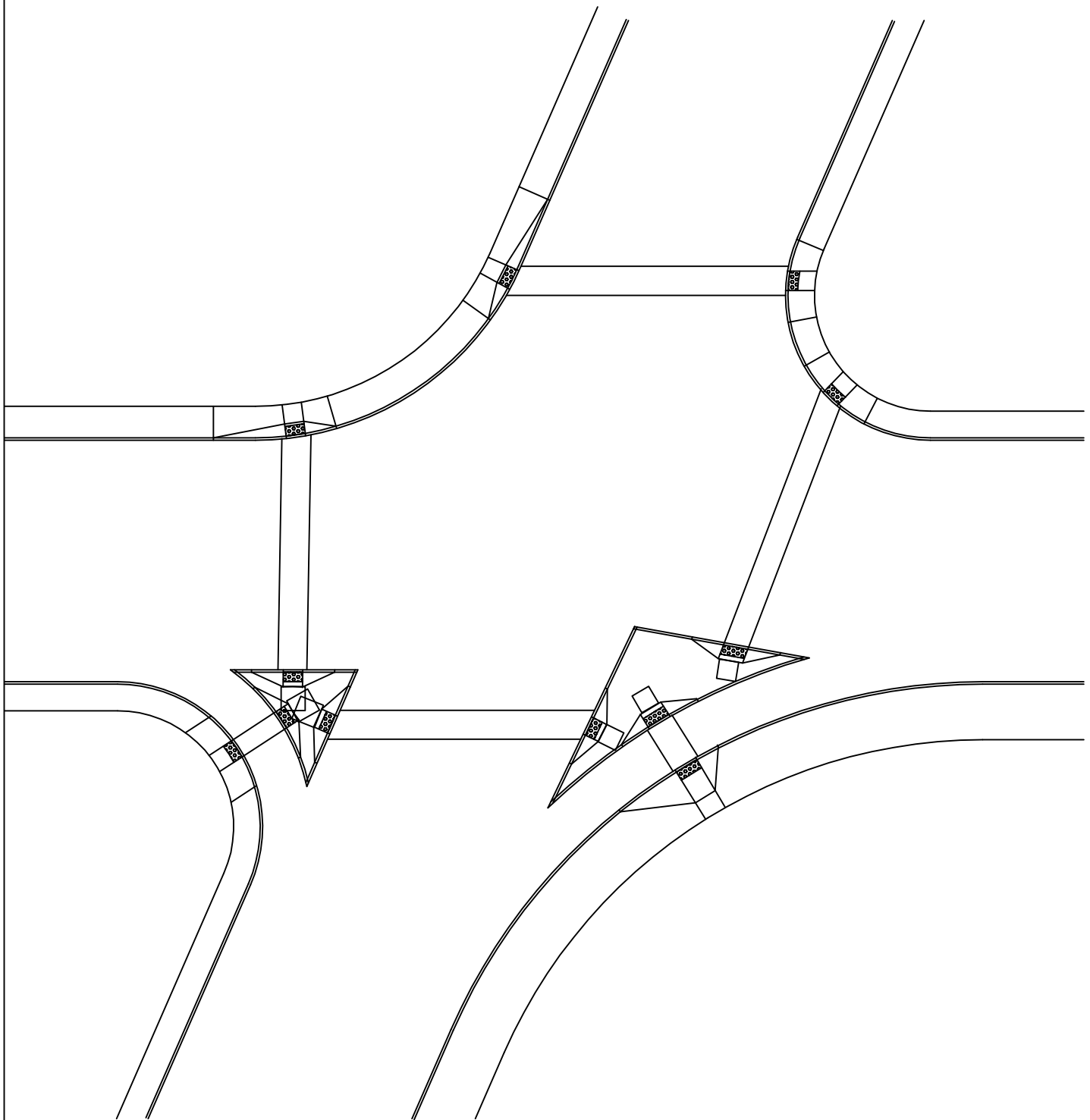
# METHOD OF SETTING SLOPED EDGING



## SLOPED EDGING

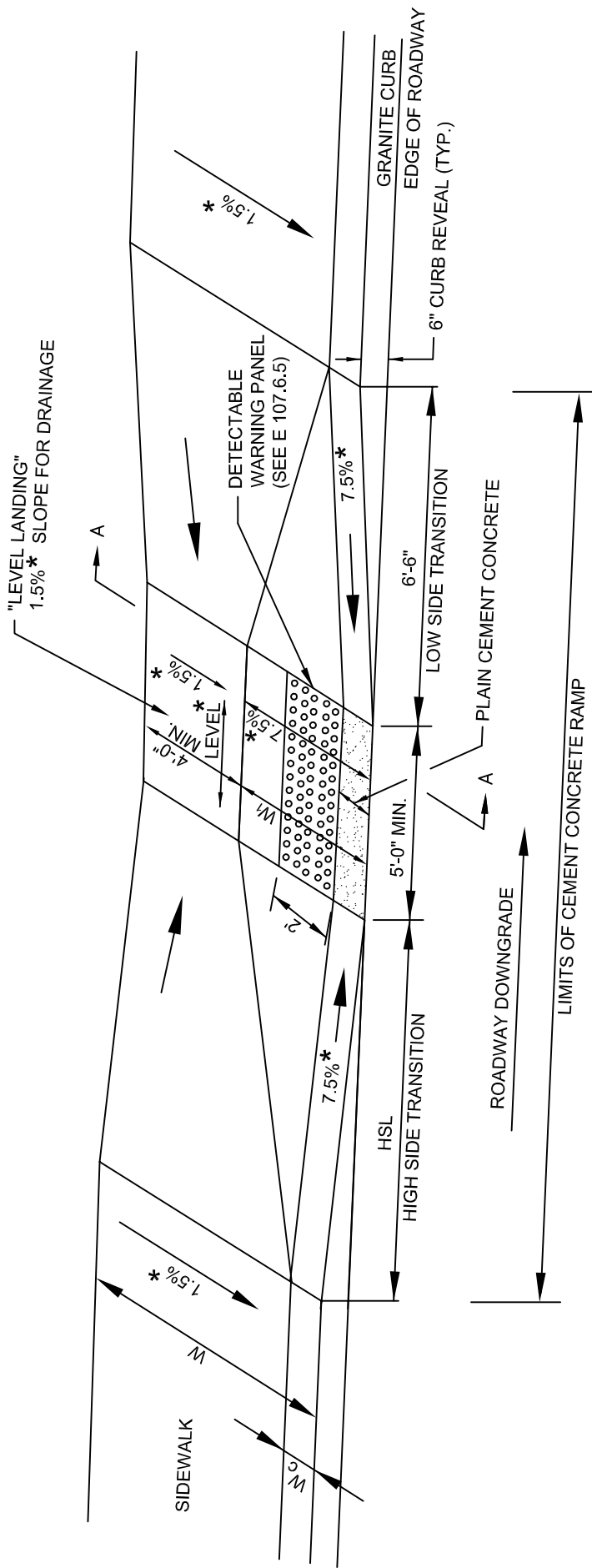
### NOTES:

1. ANY DESIGNATED CEMENT CONCRETE THAT IS ACCEPTABLE TO THE DEPARTMENT UNDER SECTION M4 OF THE STANDARD SPECIFICATIONS; ALL TEST REQUIREMENTS ARE WAIVED. HOT MIX ASPHALT SHALL NOT BE USED AS A SUBSTITUTE.
2. THE REVEAL IS TO BE A MAXIMUM OF 4" UNDER ALL CONDITIONS, THE ANGLE IS TO BE A MINIMUM OF 60° FROM VERTICAL UNDER ALL CONDITIONS.



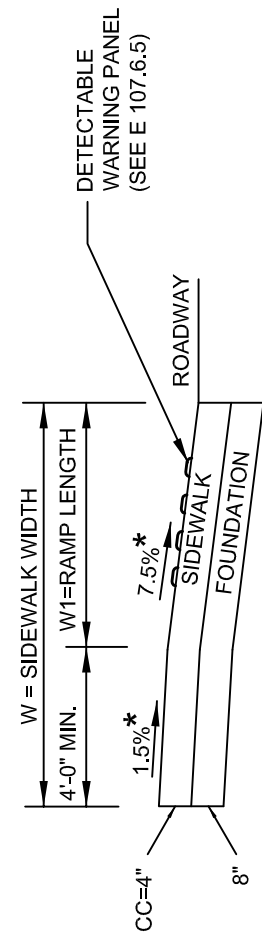
**NOTES:**

1. LEVEL LANDINGS CAN OVERLAP
2. ISLAND AREAS SUBJECT TO TRAVEL SHOULD BE TREATED AS PLAZAS "NOT MORE THAN 2% SLOPE IN ANY DIRECTION"
3. ALL RAMPS BY REGULATION MUST BE PERPENDICULAR TO THE CURB AT THE GUTTER
4. RAMPS SHOULD BE BOTH ALIGNED TOWARD THE RECEIVING RAMP AND WITHIN THE GENERALLY PREFERRED PEDESTRIAN PHASE OF TRAFFIC



**LEGEND**

- HSL = HIGH SIDE TRANSITION LENGTH  
(SEE E 107.9.0)
- W = SIDEWALK WIDTH
- W<sub>C</sub> = CURB WIDTH
- W<sub>1</sub> = PERPENDICULAR RAMP LENGTH
- CC = CEMENT CONCRETE
- \* = TOLERANCE FOR CONSTRUCTION ±0.5%
- USABLE SIDEWALK WIDTH PER AAB = W-W<sub>C</sub>
- RAMP LENGTH, W<sub>1</sub> = W-4'-0" Min



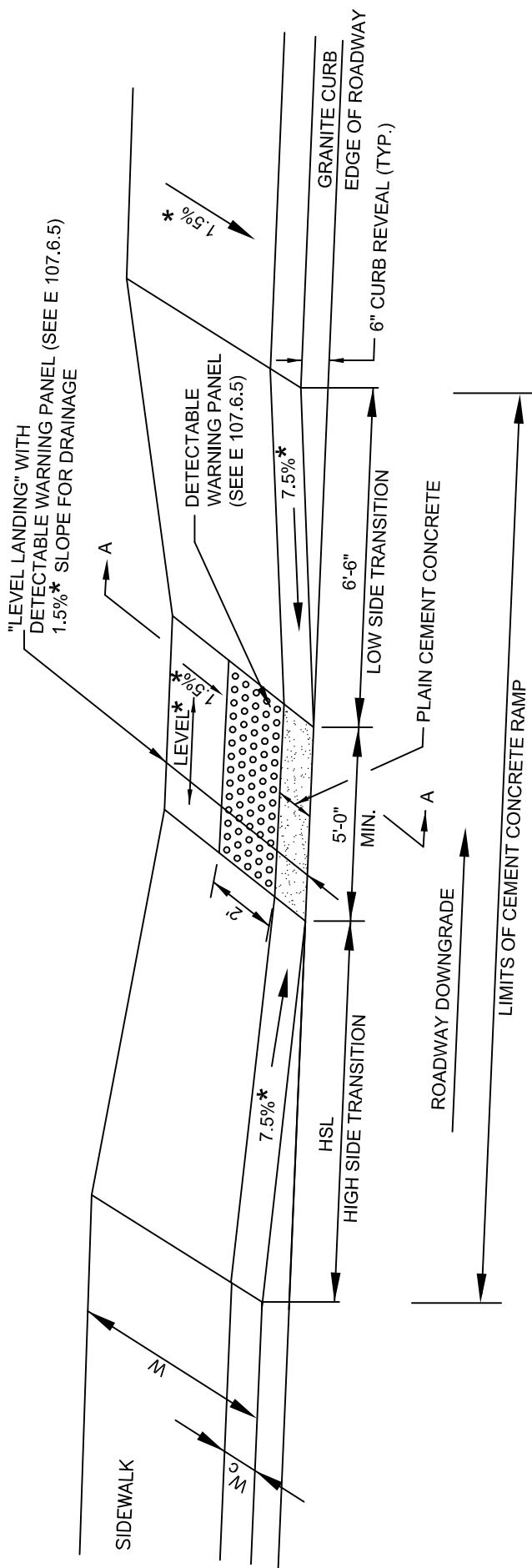
**SECTION A-A**

**WHEELCHAIR RAMPS  
LESS THAN 12'-4" SIDEWALK**

# **WHEELCHAIR RAMP ON NARROW SIDEWALK WITH DETECTABLE WARNING PANEL**

DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 107.2.1**

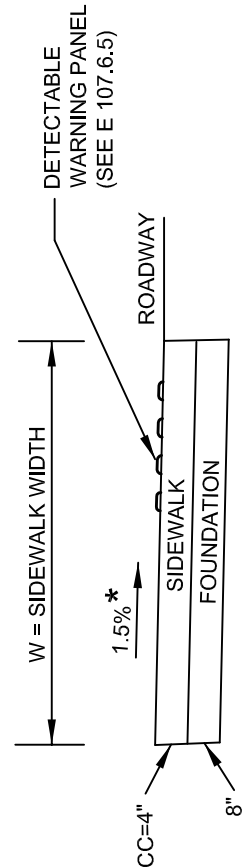


**LEGEND**

- HSL = HIGH SIDE TRANSITION LENGTH (SEE E 107.9.0)
  - W = SIDEWALK WIDTH
  - W<sub>C</sub> = CURB WIDTH
  - CC = CEMENT CONCRETE
  - \* = TOLERANCE FOR CONSTRUCTION ±0.5%
- USABLE SIDEWALK WIDTH PER AAB = W-W<sub>C</sub>  
USABLE SIDEWALK WIDTH PER AAB IS NOT TO BE LESS THAN 4'0"  
SEE E 107.6.5 FOR DETAILS OF DETECTABLE WARNING PANEL

**NOTE:**

ROADWAY, GUTTER, AND FIRST 6" OF SIDEWALK TO BE ADJUSTED FOR FIELD CONDITIONS

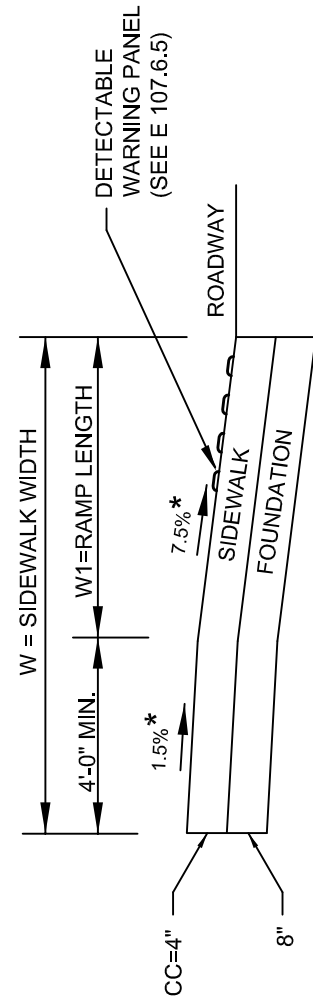
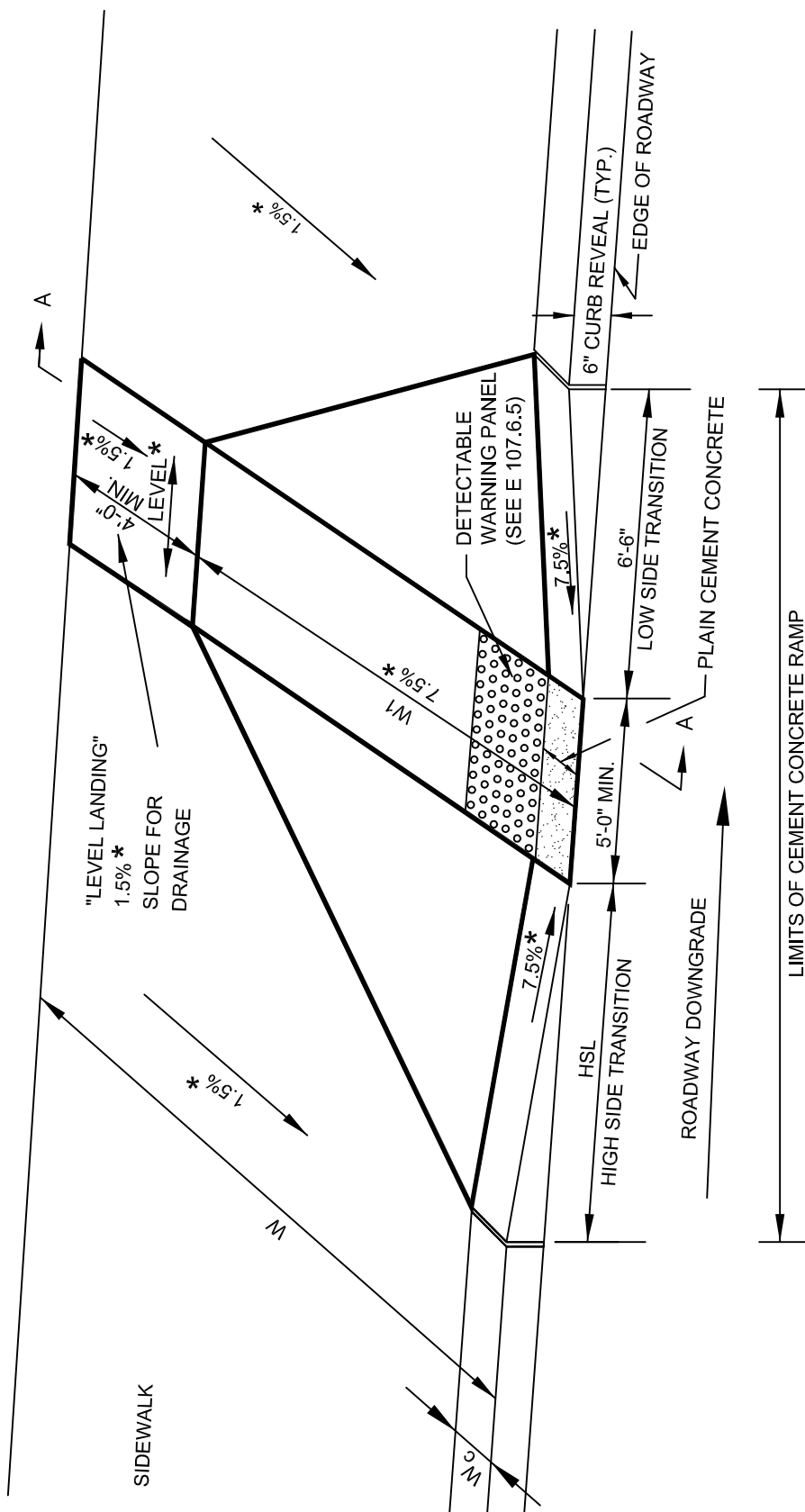


**SECTION A-A**

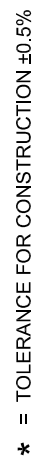
# **WHEELCHAIR RAMPS GREATER THAN 12'-4" SIDEWALK**

## **LEGEND**

- HSL = HIGH SIDE TRANSITION LENGTH  
(SEE E 107.9.0)
  - W = SIDEWALK WIDTH
  - W<sub>C</sub> = CURB WIDTH
  - W<sub>1</sub> = PERPENDICULAR RAMP LENGTH
  - C<sub>c</sub> = CEMENT CONCRETE
  - \* = TOLERANCE FOR CONSTRUCTION ±0.5%
- USABLE SIDEWALK WIDTH PER AAB = W-W<sub>C</sub>
- RAMP LENGTH, W<sub>1</sub> = W-4'-0" Min

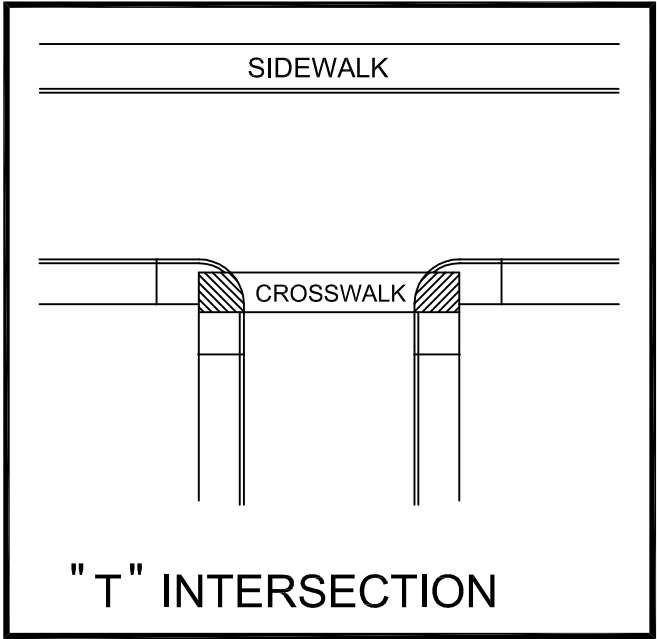


**SECTION A-A**



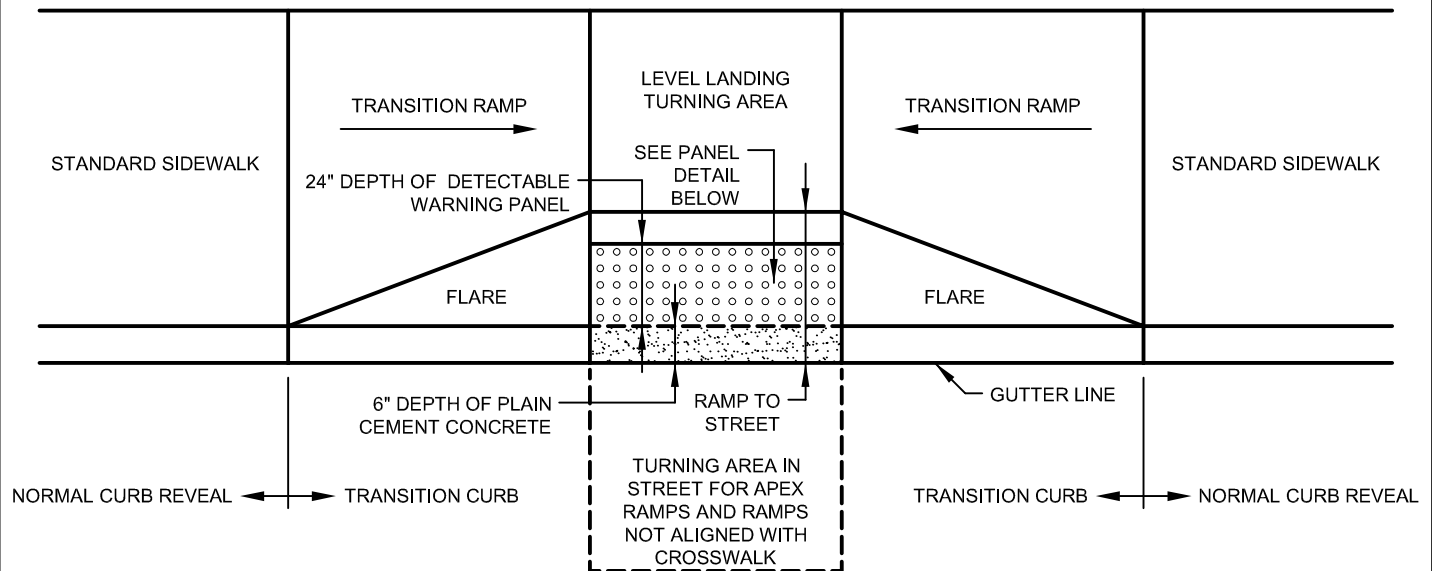




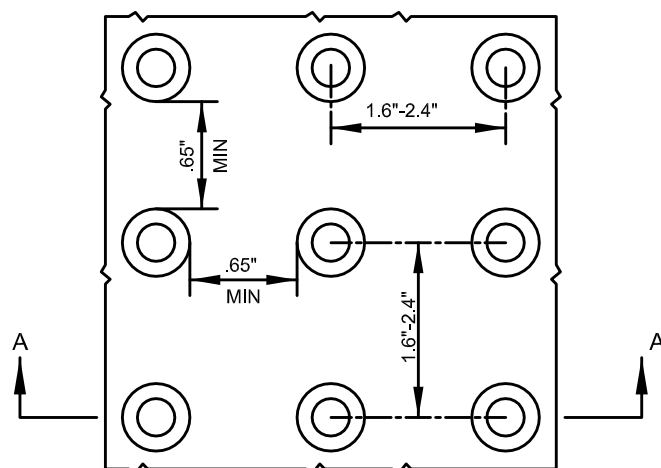


**\*\* TOLERANCE FOR CONSTRUCTION  $\pm 0.5\%$**

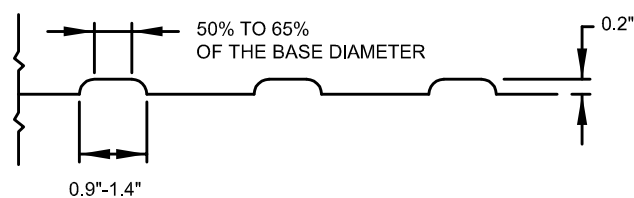
ROADWAY, GUTTER, AND FIRST 6"  
OF SIDEWALK TO BE ADJUSTED  
FOR FIELD CONDITIONS



TYPICAL INSTALLATION



DETAIL OF DETECTABLE WARNING PANEL



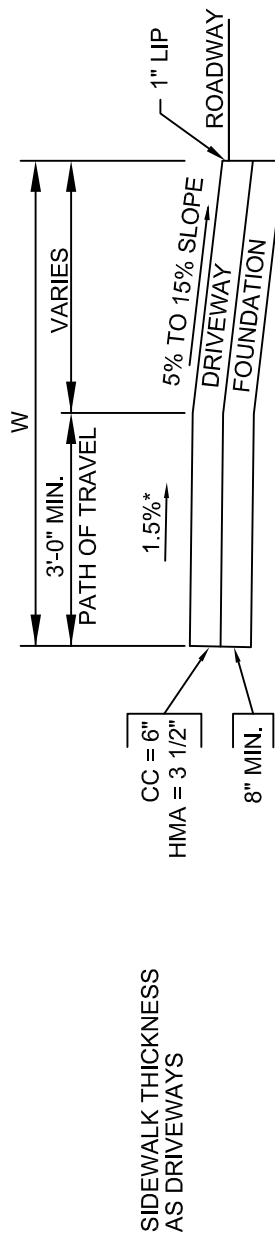
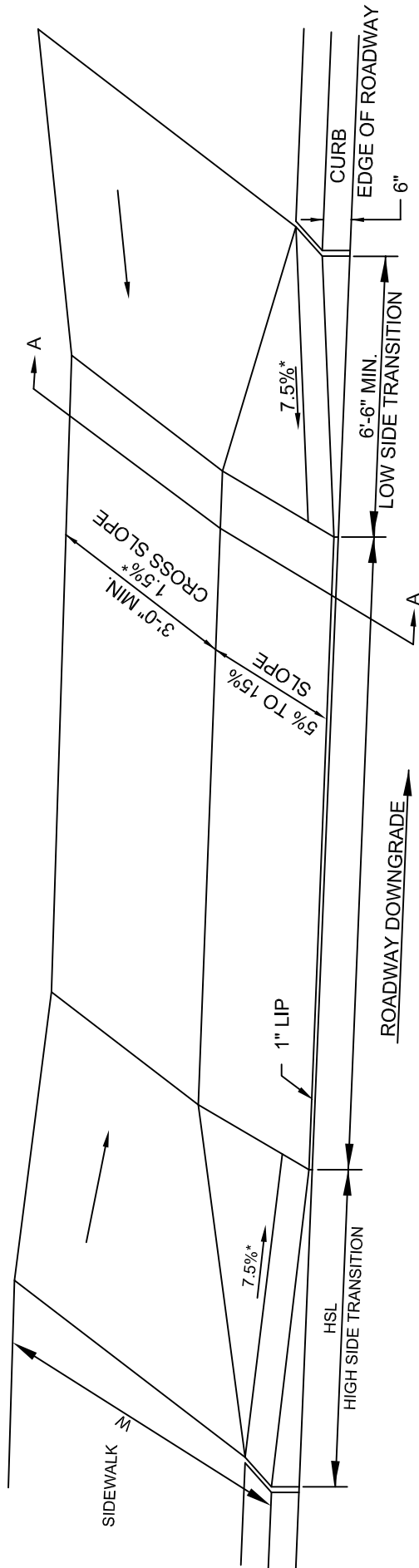
SECTION A-A

**NOTE:**

PANELS MAY BE CONCRETE PRECAST OR CAST IN PLACE OR OTHER SUITABLE MATERIAL PERMANENTLY APPLIED TO THE RAMP. DETECTABLE WARNING SURFACES SHALL CONTRAST VISUALLY WITH ADJACENT WALKING SURFACES EITHER LIGHT-ON-DARK, OR DARK-ON-LIGHT.



\*\*\* = SEE E 107.9.0 FOR TRANSITION LENGTH



SECTION A-A

**LEGEND**

HSL = HIGH SIDE TRANSITION LENGTH. SEE E 107.9.0

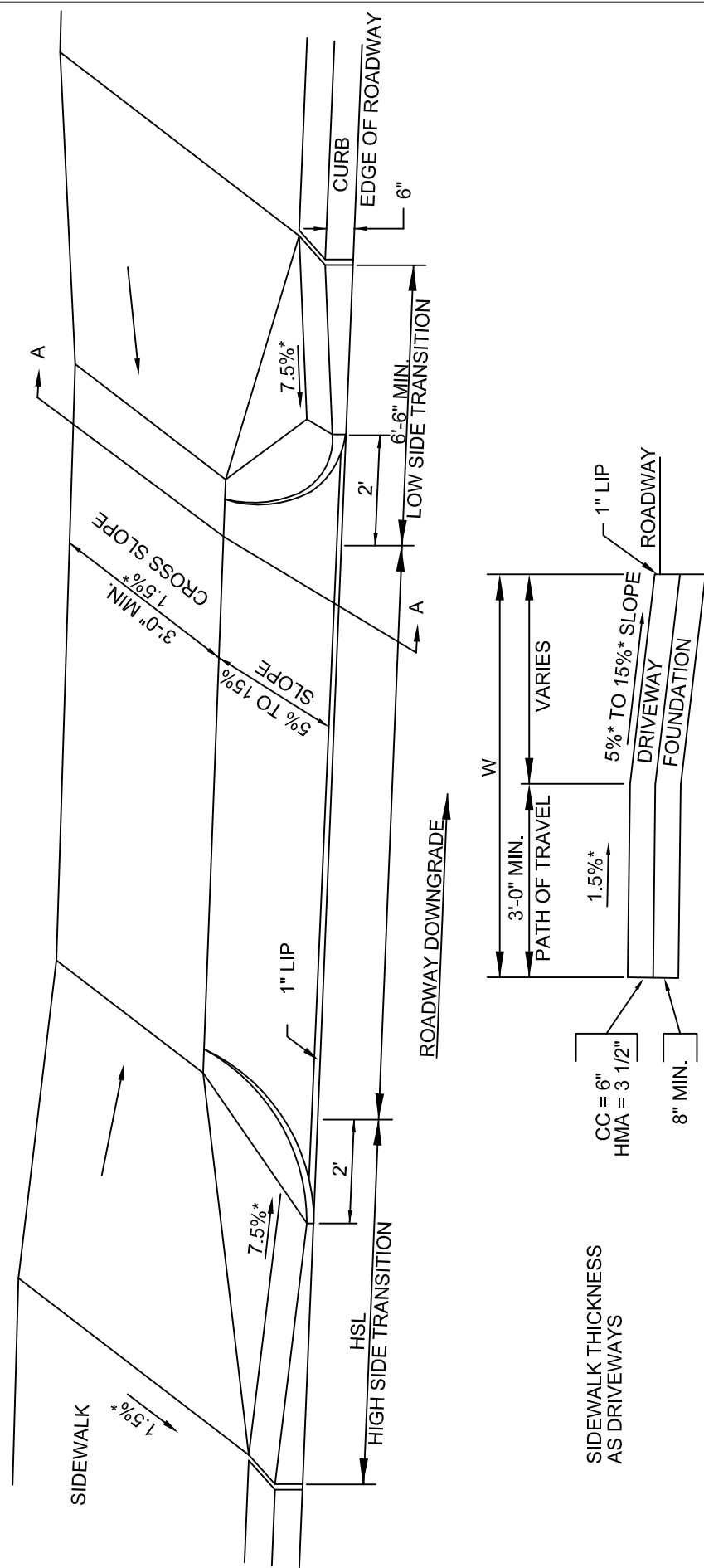
W = SIDEWALK WIDTH

\* = TOLERANCE FOR CONSTRUCTION  $\pm 0.5\%$

CC = CEMENT CONCRETE

HMA = HOT MIX ASPHALT

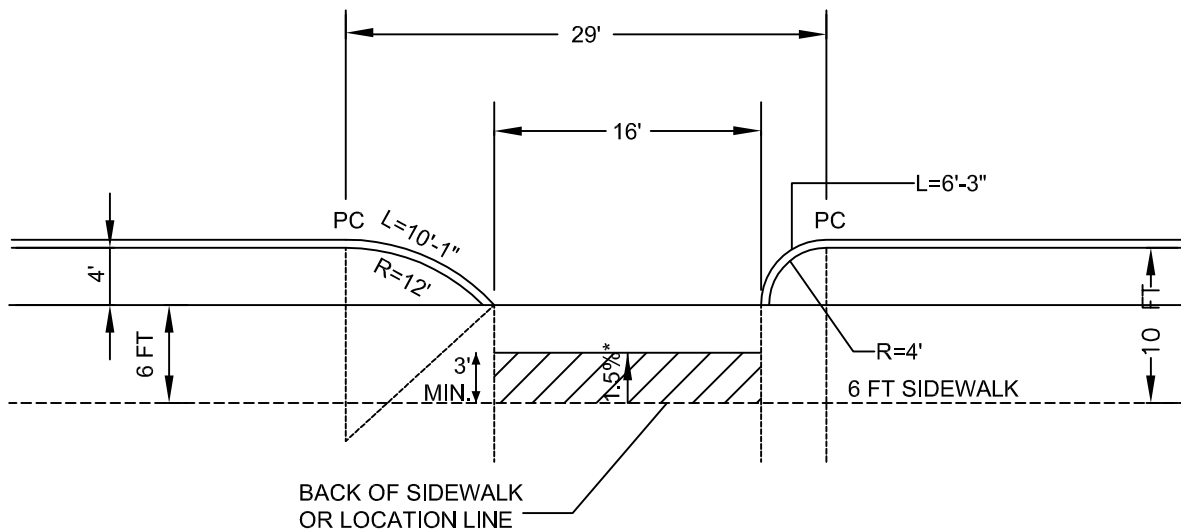
# **SIDEWALK THROUGH DRIVEWAYS WITH CURB RETURNS 2' CURB CORNERS**



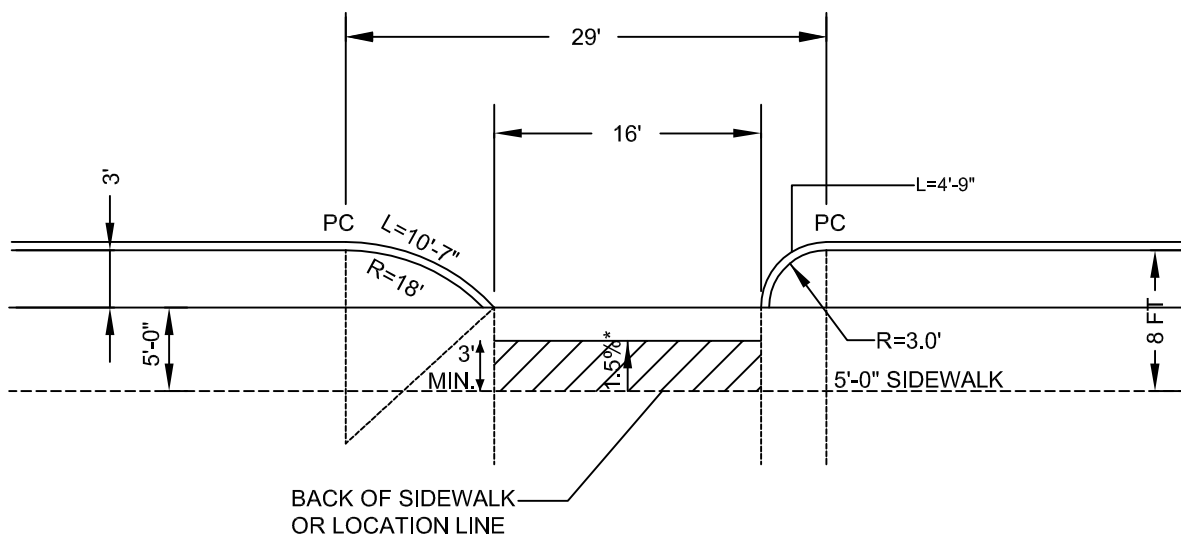
SECTION A-A

**LEGEND**

- HSL = HIGH SIDE TRANSITION LENGTH. SEE E 107.9.0
- W = SIDEWALK WIDTH
- \* = TOLERANCE FOR CONSTRUCTION  $\pm 0.5\%$
- CC = CEMENT CONCRETE
- HMA = HOT MIX ASPHALT



## 10 FT SIDEWALK LAYOUT



## 8 FT SIDEWALK LAYOUT

### NOTES:

1. WHEN THE SIDEWALK IS PAVED TO THE CURB LINE, USE SHORT CURB RETURNS AT THE HIGHWAY CURB LINE PC'S, SHOWN IN THESE DESIGNS.



\*MUST MAINTAIN PATH OF TRAVEL WITH 1.5% CROSS SLOPE ( $\pm 0.5\%$  CONSTRUCTION TOLERANCE)

## CURB TRANSITION LENGTH FOR WHEELCHAIR RAMPS

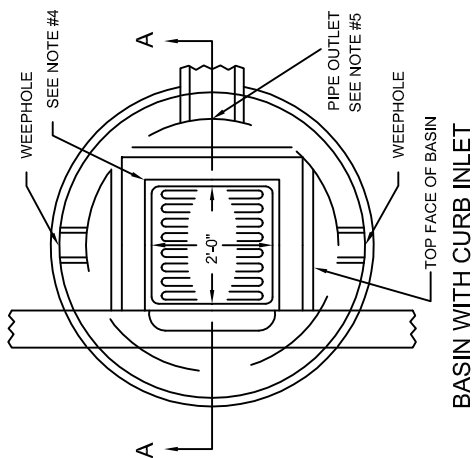
ROADWAY PROFILE GRADE	* HIGH SIDE TRANSITION LENGTH
%	ENGLISH UNITS
=0%	6'-6"
>0% TO 1%	7'-8"
>1% TO 2%	9'-0"
>2% TO 3%	11'-0"
>3% TO 4%	14'-0"
>4% TO 5%	15'-0" Max

NOTE:

\* BASED ON A DESIGN SLOPE OF  
7.5% AND A REVEAL OF 6" .



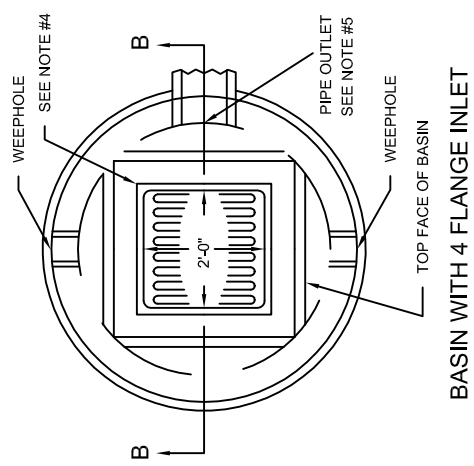
# **CONCRETE BLOCK CATCH BASIN**



\* MINIMUM DEPTH OF SUMP TO BE 2' STANDARD DEPTH 3'

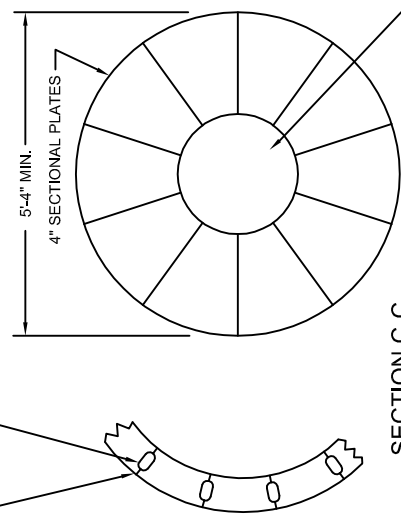
**NOTES:**

1. WEEPHOLES SHALL BE 4" PIPE OPENING OR EQUIVALENT WITH 1/4 IN. MESH, 23 GAGE GALVANIZED WIRE SCREEN COVERING. 2 CUBIC FEET OF CRUSHED STONE SHALL BE PLACED AROUND EACH WEEPHOLE.
2. BRICKS MAY BE USED BETWEEN TOP COURSE AND C.B. FRAME FOR GRADE ADJUSTMENT. FRAME SHALL BE SET IN FULL BED OF MORTAR.
3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
4. DETAILS SHOWN ON DRAWINGS E 201.6.0 - E 201.11.0
5. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4 IN. FROM FACE OF WALL ALONG CENTERLINE OF PIPE.



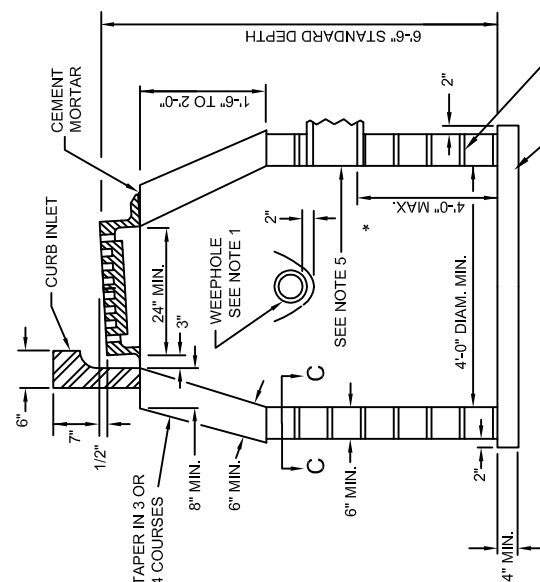
MORTAR NOT REQUIRED IN VERTICAL JOINTS  
KEYWAYS TO BE FILLED WITH CEMENT MORTAR

**PLAN OF BASE**



**SECTION C-C**

SOLID SECTION, OR FILL HOLE WITH BRICKS AND MORTAR, OR FILL WITH 4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) (IF CONCRETE IS HAND MIXED SEE LATEST SPECIFICATIONS.)

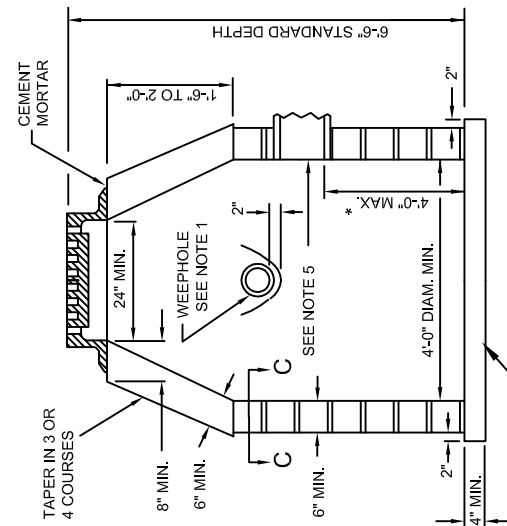


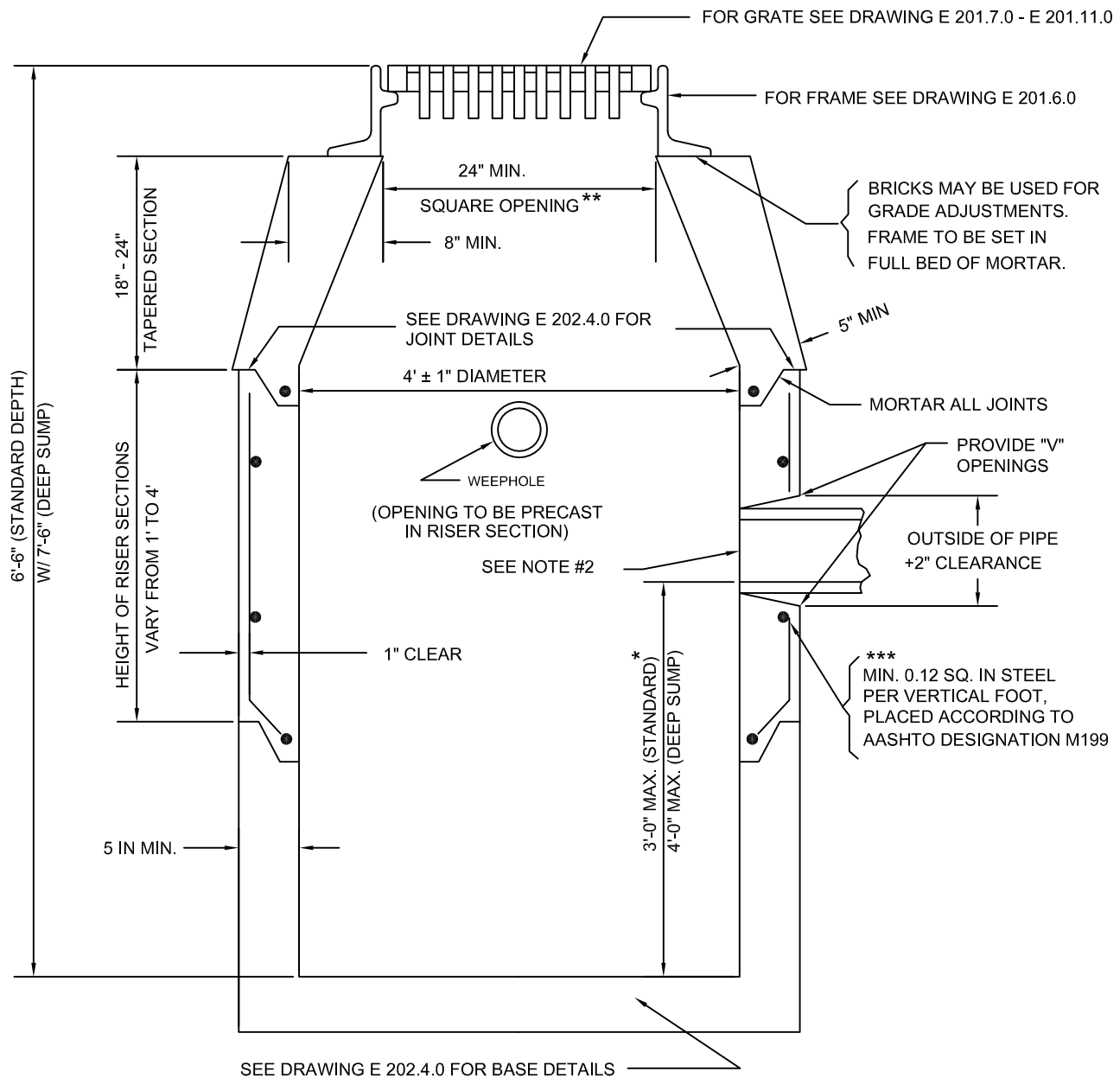
**SECTION A-A**

BLOCKS TO BE SET IN FULL BED OF CEMENT MORTAR

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) OR PRECAST CONCRETE SECTIONAL PLATES. SEE ABOVE.

**SECTION B-B**

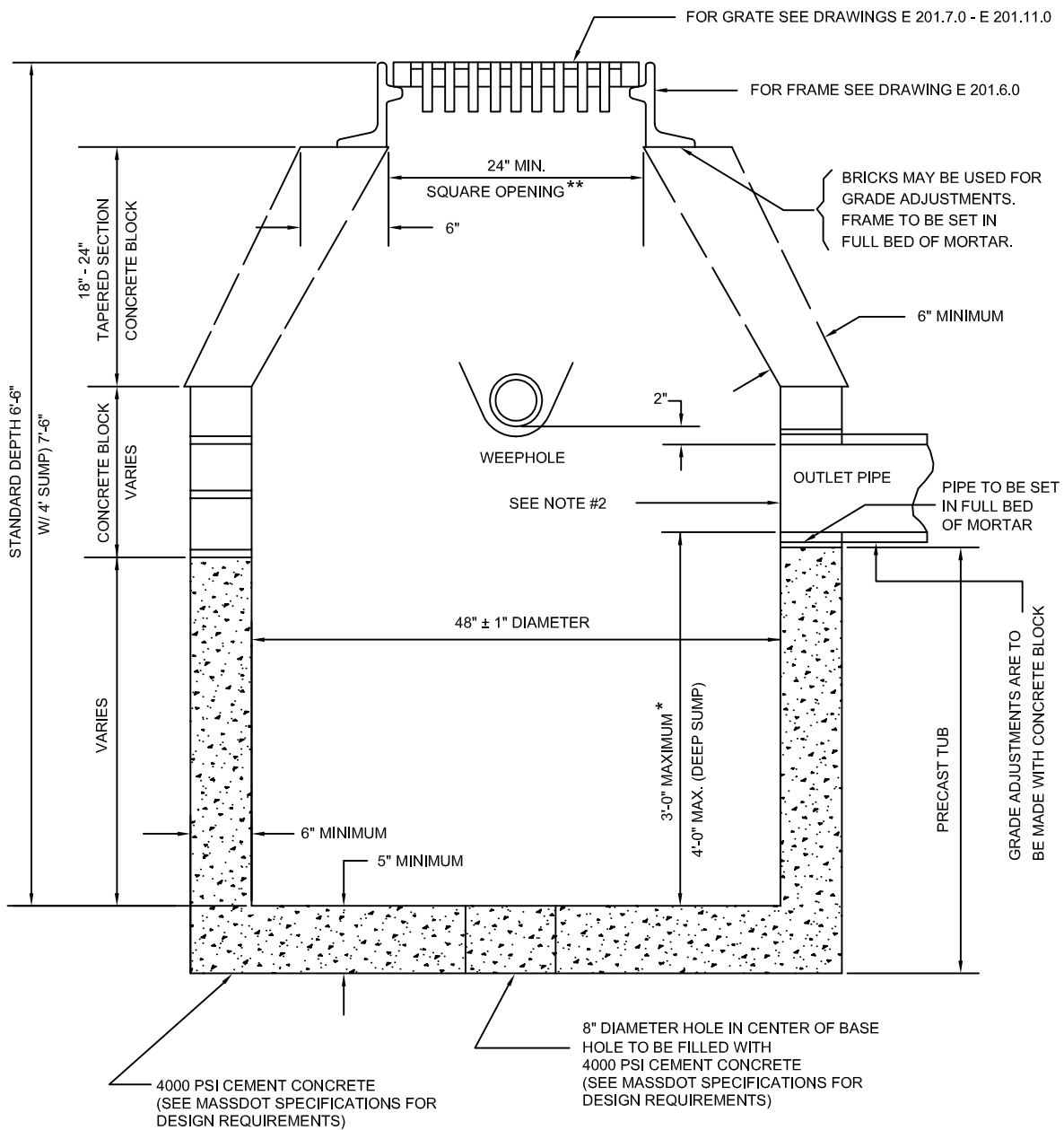




- \* MINIMUM DEPTH OF SUMP TO BE 2 FT
- \*\* WHEN A CURB INLET IS INSTALLED, THE OPENING IS TO BE 24"±1" X 27"±1"
- \*\*\* REINFORCING STEEL BASED ON A WALL THICKNESS OF 5".

**NOTES:**

1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON E 201.3.0
2. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL  
ALONG CENTERLINE OF PIPE.
3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE STANDARD SPECIFICATIONS.
4. ALL CONCRETE TO BE AIR ENTRAINED

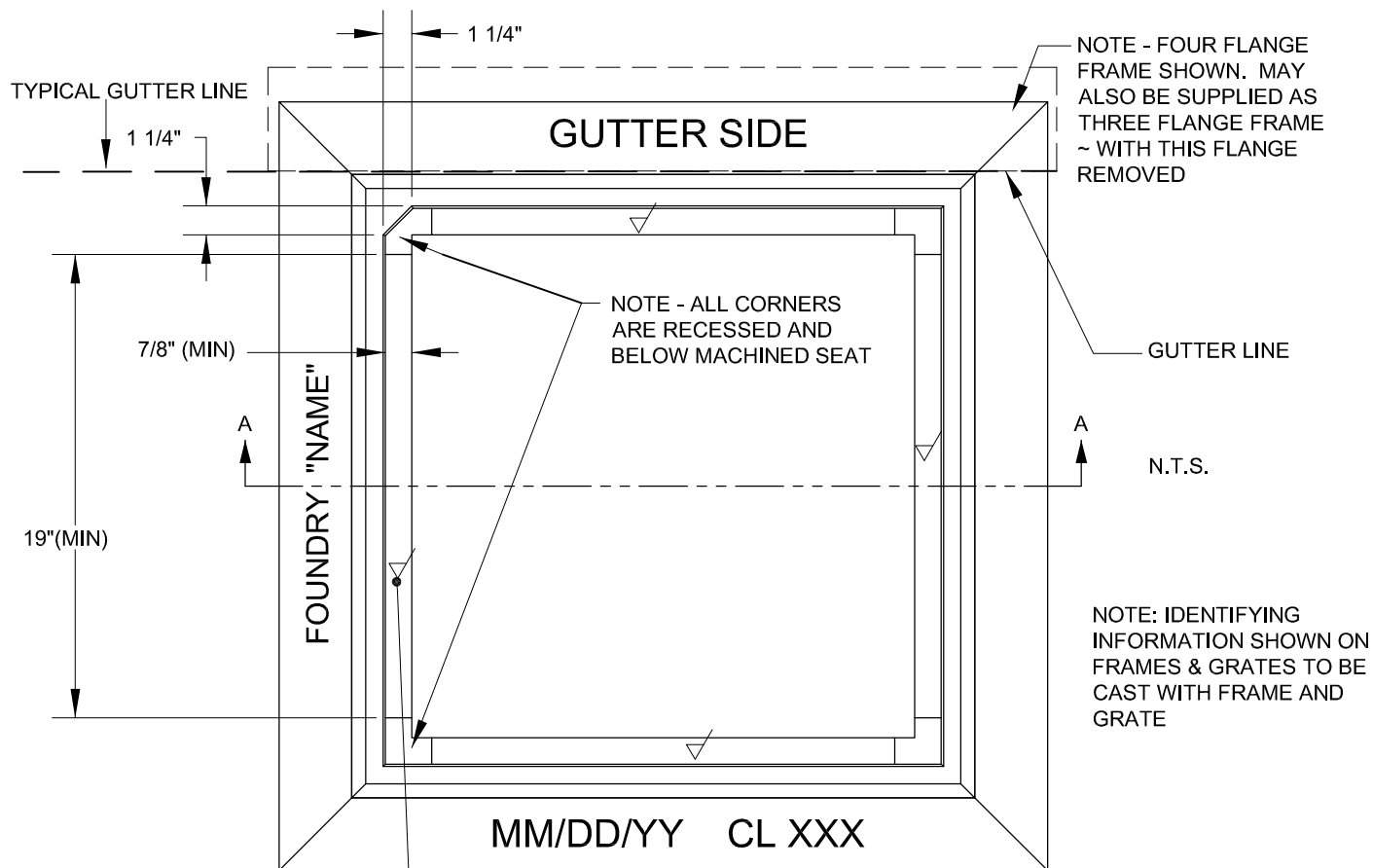


\* MINIMUM DEPTH OF SUMP TO BE 2'

\*\* WHEN A CURB INLET IS INSTALLED, THE OPENING IS TO BE 24"±1" X 27"±1"

#### NOTES:

1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON DRAWING E 201.3.0
2. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL  
ALONG CENTERLINE OF PIPE.
3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE STANDARD SPECIFICATIONS.
4. ALL CONCRETE TO BE AIR ENTRAINED

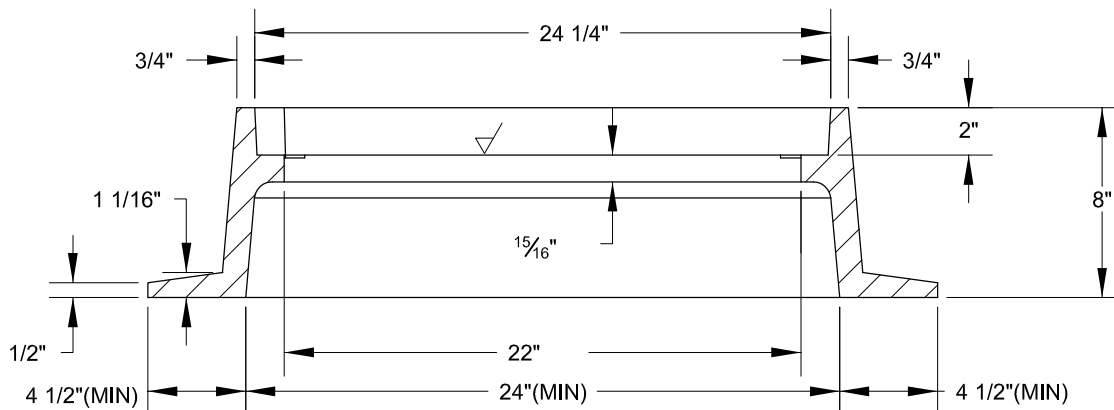


**MACHINE TOLERANCES:**

▽ MACHINED SEATS (4) REQUIRED  
FLAT AND IN PLANE WITHIN .010"  
TOTAL INDICATOR READING

**CLASSIFICATION:**

**CAST IRON - SEE STANDARD SPECIFICATIONS**  
WITH NO BLACK ASPHALT COATING ALLOWED



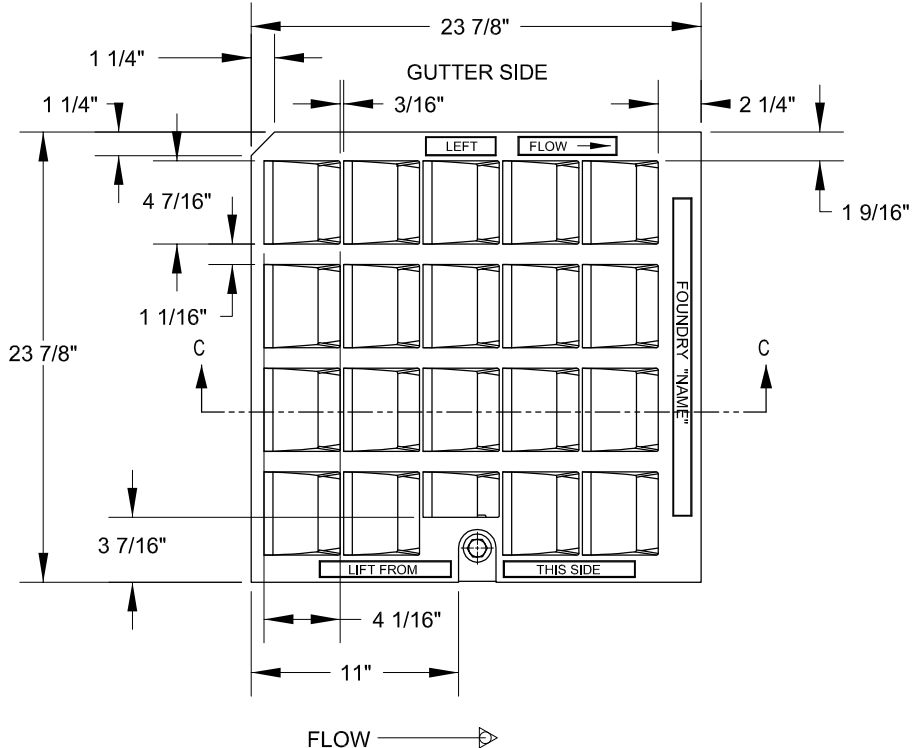
**WEIGHTS:**

3-FLANGE FRAME 240 LBS. MIN  
4-FLANGE FRAME 270 LBS. MIN

AASHTO HS 20 LOAD RATED

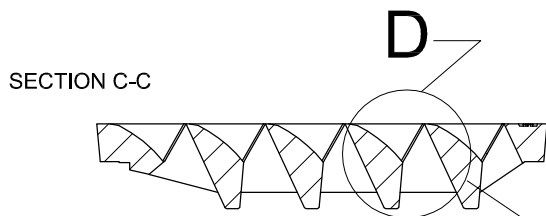
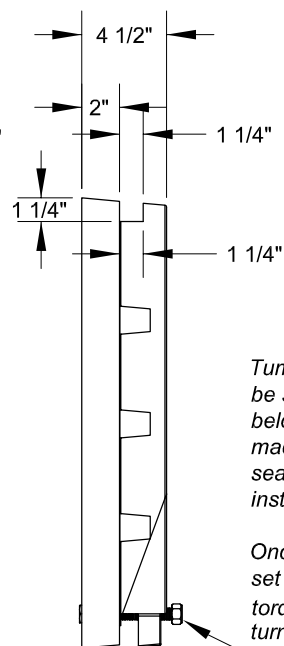
**CASTING TOLERANCES:**

SHALL CONFORM TO AASHTO  
M306



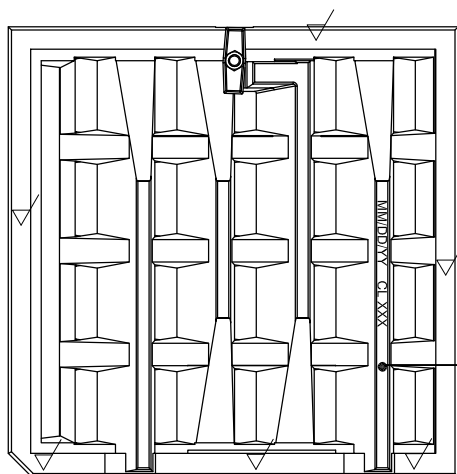
END VIEW

N.T.S.



SECTION C-C


CLASSIFICATION:  
**CAST IRON - SEE STANDARD SPECIFICATIONS**  
 WITH NO BLACK ASPHALT COATING ALLOWED



WEIGHT: 265 LBS. MIN  
 AASHTO HS 20 PROOF LOAD

NOTE: IDENTIFYING INFORMATION  
 SHOWN ON FRAMES & GRATES TO BE  
 CAST WITH FRAME AND GRATE

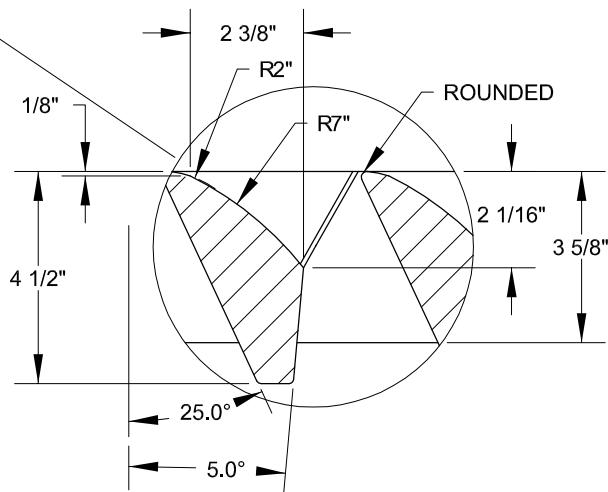
Machine tolerances:

Surfaces noted  must  
 be machined flat and  
 in-plane within .010"  
 Total Indicator Reading

LOCK TUMBLER ASSEMBLY  
 (1) REQUIRED~CONSISTS OF:

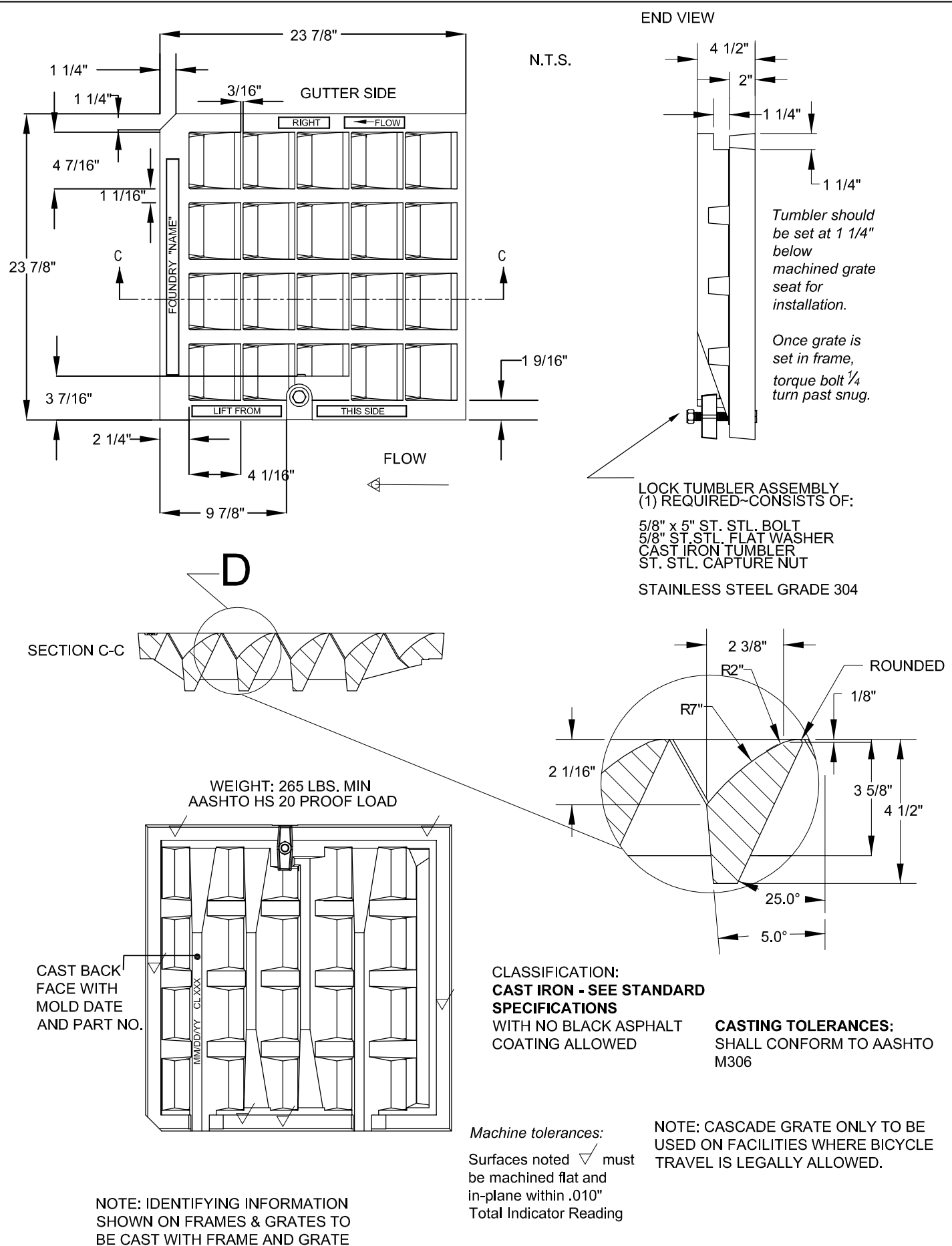
5/8" x 5" ST. STL. BOLT  
 5/8" ST. STL. FLAT WASHER  
 CAST IRON TUMBLER  
 ST. STL. CAPTURE NUT

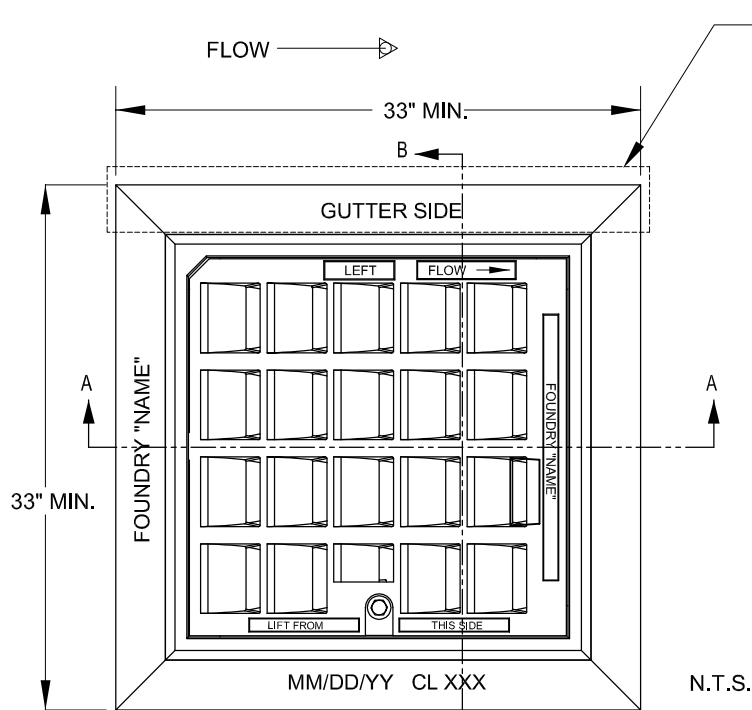
STAINLESS STEEL GRADE 304



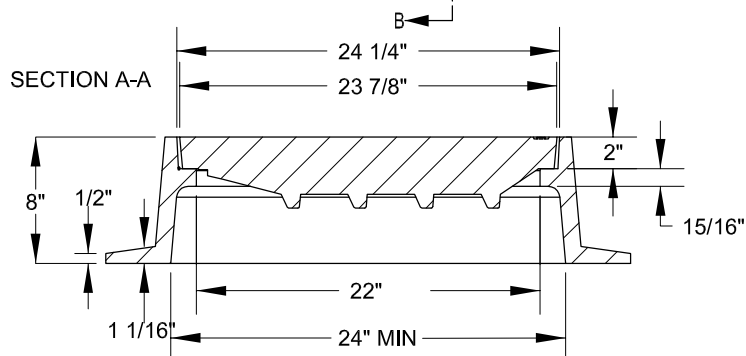
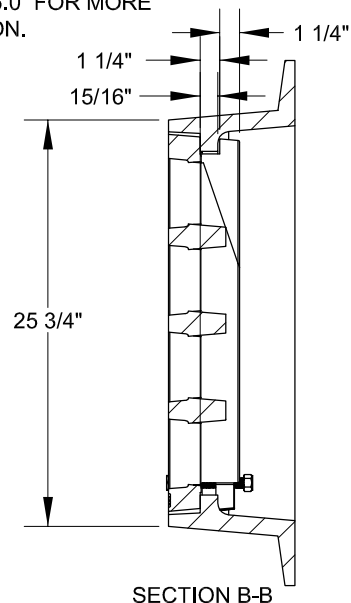
**CASTING TOLERANCES:**  
 SHALL CONFORM TO AASHTO  
 M306

NOTE: CASCADE GRATE ONLY TO BE  
 USED ON FACILITIES WHERE BICYCLE  
 TRAVEL IS LEGALLY ALLOWED.

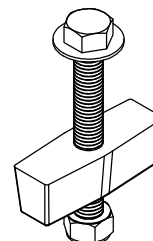




FRAME MAY BE INSTALLED WITH THIS FLANGE REMOVED FOR CURB INLET. FOUR FLANGE IS SHOWN. ~ SEE DWG E 201.6.0 FOR MORE INFORMATION.



AASHTO HS 20 PROOF LOAD



LOCK TUMBLER ASSEMBLY  
(1) REQUIRED~CONSISTS OF:

5/8" x 5" ST. STL. BOLT  
5/8" ST. STL. FLAT WASHER  
CAST IRON TUMBLER  
ST. STL. CAPTURE NUT

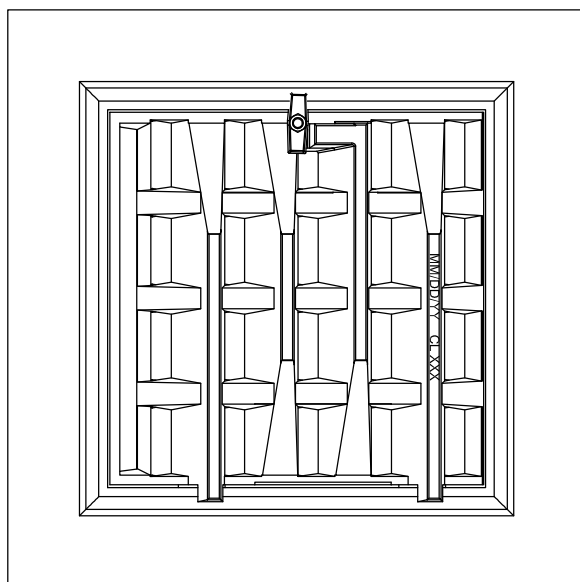
STAINLESS STEEL GRADE 304

CLASSIFICATION:  
**CAST IRON - SEE STANDARD SPECIFICATIONS**  
WITH NO BLACK ASPHALT COATING ALLOWED

*Tumbler should be set at 1 1/4" below machined grate seat for installation.*

*Once grate is set in frame, torque bolt 1/4 turn past snug.*

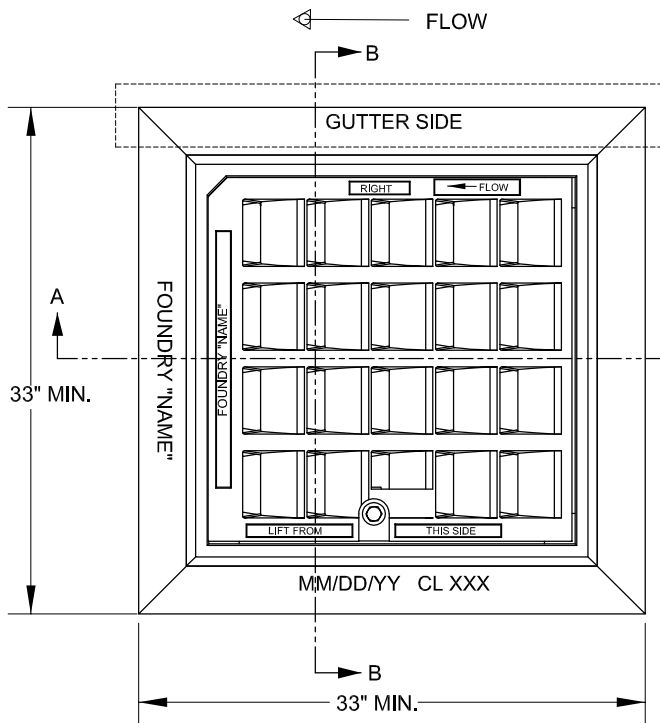
WEIGHTS:  
3-FLANGE FRAME 240 LBS. MIN  
4-FLANGE FRAME 270 LBS. MIN  
B-1 GRATE 265 LBS. MIN



NOTE: SEAT SURFACES ON BOTH FRAME AND GRATE ARE MACHINED AND GRATE MUST NOT ROCK IN FRAME WHEN ASSEMBLED.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE

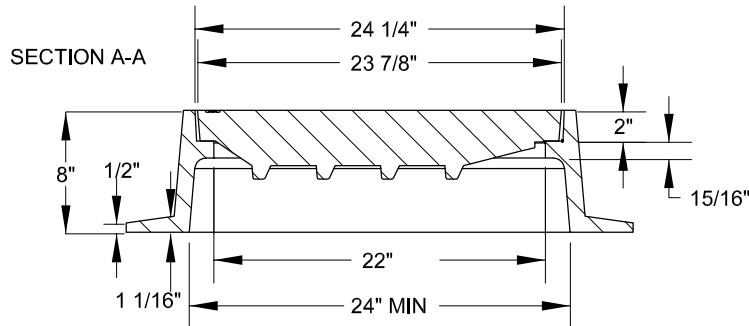
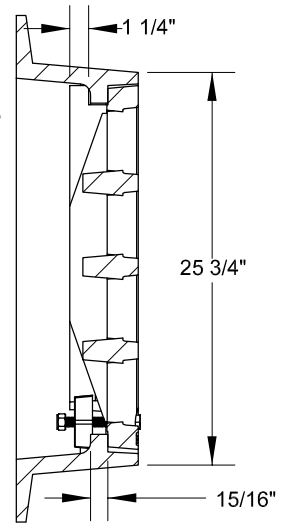
**CASTING TOLERANCES:**  
SHALL CONFORM TO AASHTO M306



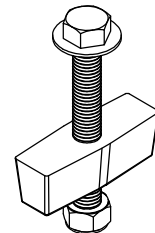
FRAME MAY BE INSTALLED  
WITH THIS FLANGE REMOVED  
FOR CURB INLET. FOUR  
FLANGE IS SHOWN. ~ SEE  
DWG E 201.6.0 FOR MORE  
INFORMATION.

CLASSIFICATION:  
**CAST IRON - SEE STANDARD  
SPECIFICATIONS**  
WITH NO BLACK ASPHALT  
COATING ALLOWED

AASHTO HS 20 PROOF LOAD  
N.T.S.



SECTION B-B



LOCK TUMBLER ASSEMBLY  
(1) REQUIRED~CONSISTS OF:

5/8" x 5" ST. STL. BOLT  
5/8" ST. STL. FLAT WASHER  
CAST IRON TUMBLER  
ST. STL. CAPTURE NUT

STAINLESS STEEL GRADE 304

*Tumbler should be set at 1 1/4" below machined grate seat  
for installation.*

*Once grate is set in frame, torque bolt 1/4 turn past snug.*

WEIGHTS:

3-FLANGE FRAME	240 LBS. MIN
4-FLANGE FRAME	270 LBS. MIN
B-2 GRATE	265 LBS. MIN

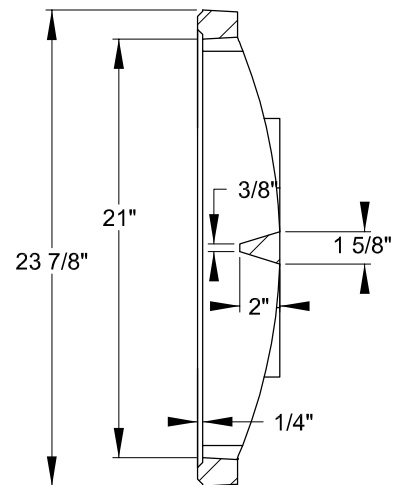
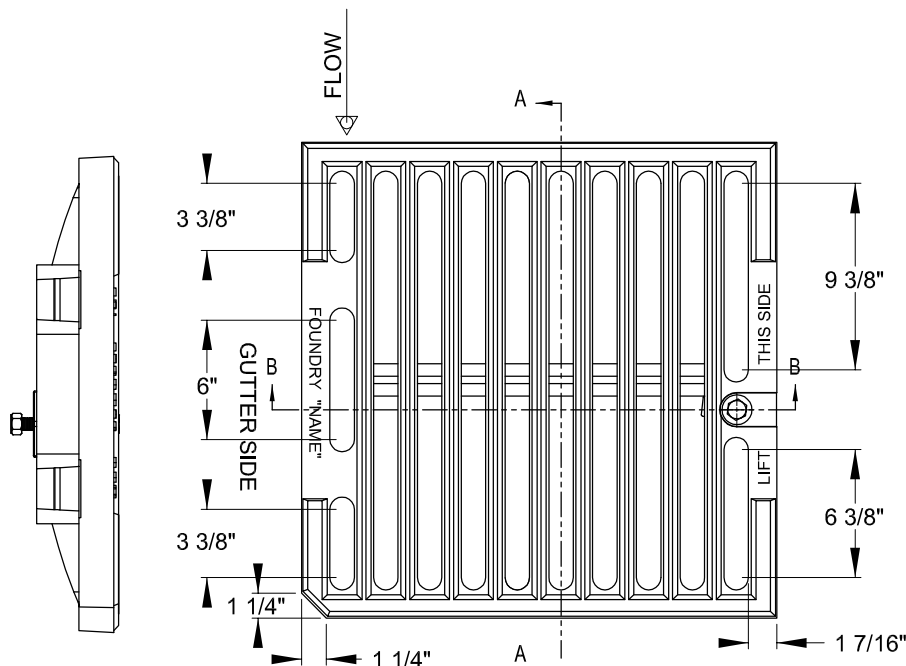
**CASTING TOLERANCES:**

SHALL CONFORM TO AASHTO  
M306

NOTE: SEAT SURFACES ON BOTH FRAME AND GRATE ARE MACHINED  
AND GRATE MUST NOT ROCK IN FRAME WHEN ASSEMBLED.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO  
BE CAST WITH FRAME AND GRATE

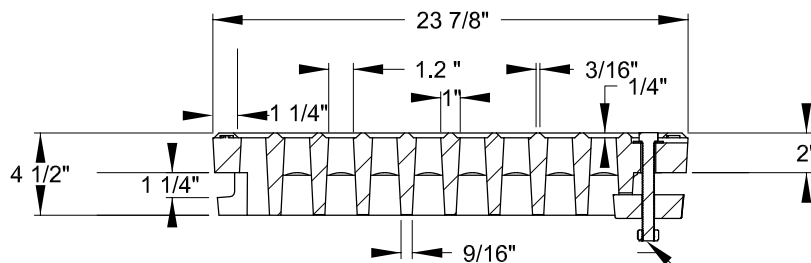




N.T.S.

WEIGHT: 205 LBS. (MIN)

NOTE: IDENTIFYING  
INFORMATION SHOWN ON  
FRAMES & GRATES TO BE  
CAST WITH FRAME AND  
GRATE



LOCK TUMBLER ASSEMBLY


(1) REQUIRED~CONSISTS OF:

5/8" x 5" ST. STL. BOLT  
5/8" ST. STL. FLAT WASHER  
CAST IRON TUMBLER  
ST. STL. CAPTURE NUT  
STAINLESS STEEL GRADE 304

AASHTO HS 20 PROOF LOAD

CLASSIFICATION:  
**CAST IRON - SEE STANDARD  
SPECIFICATIONS**  
WITH NO BLACK ASPHALT  
COATING ALLOWED

*Machine tolerances:*

Surfaces noted  must  
be machined flat and  
in-plane within .010"  
Total Indicator Reading

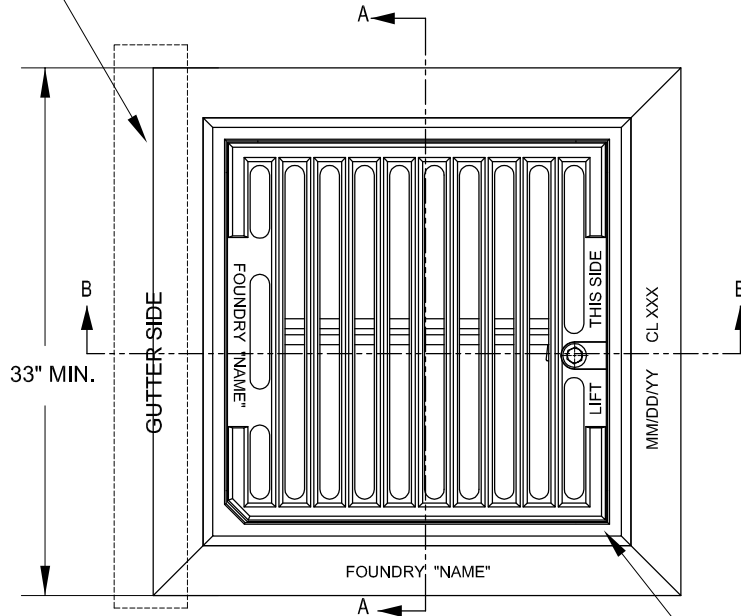
**CASTING TOLERANCES:**  
SHALL CONFORM TO AASHTO M306

*Tumbler should be set at 1 1/4" below machined grate seat for installation.*

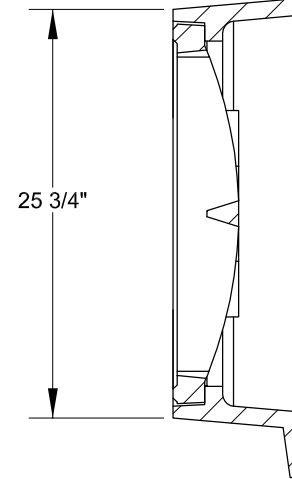
*Once grate is set in frame, torque bolt  $\frac{1}{4}$  turn past snug.*

NOTE: BAR GRATE NOT TO BE USED ON  
FACILITIES WHERE BICYCLE TRAVEL IS  
LEGALLY ALLOWED.

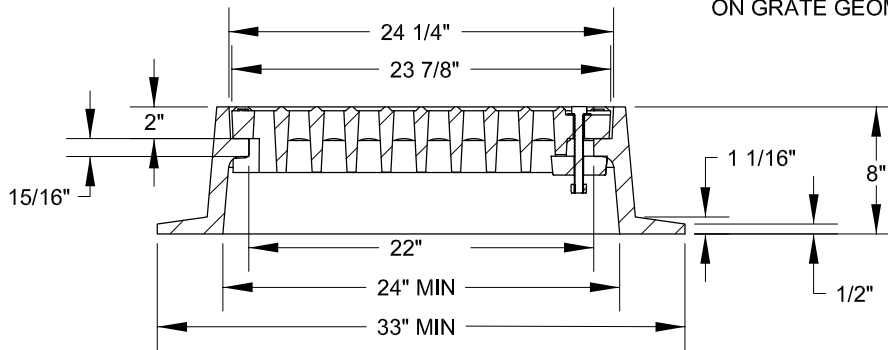
FRAME MAY BE INSTALLED WITH THIS FLANGE REMOVED FOR CURB INLET. FOUR FLANGE IS SHOWN. SEE DWG 201.6.0 R2 FOR MORE INFORMATION.



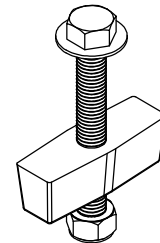
NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE



SEE DWG # FOR MORE INFORMATION ON GRATE GEOMETRY.



N.T.S.

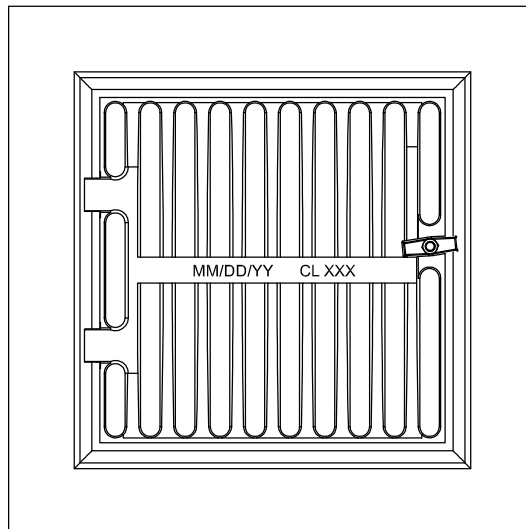


LOCK TUMBLER ASSEMBLY  
(1) REQUIRED~CONSISTS OF:

5/8" x 5" ST. STL. BOLT  
5/8" ST. STL. FLAT WASHER  
CAST IRON TUMBLER  
ST. STL. CAPTURE NUT

STAINLESS STEEL GRADE 304

AASHTO  
HS 20  
PROOF  
LOAD



**CASTING TOLERANCES:**  
SHALL CONFORM TO AASHTO  
M306

**CLASSIFICATION:**  
**CAST IRON - SEE STANDARD SPECIFICATIONS**  
WITH NO BLACK ASPHALT COATING ALLOWED

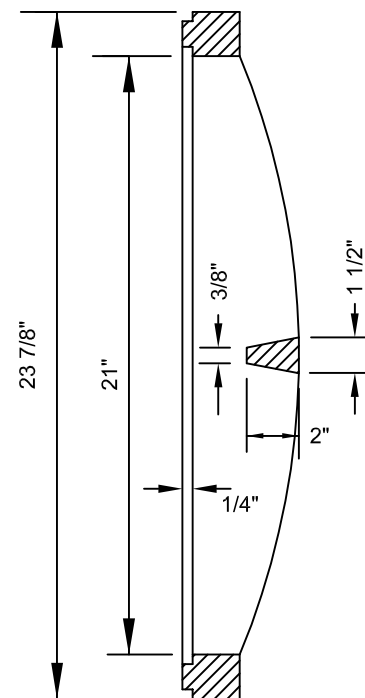
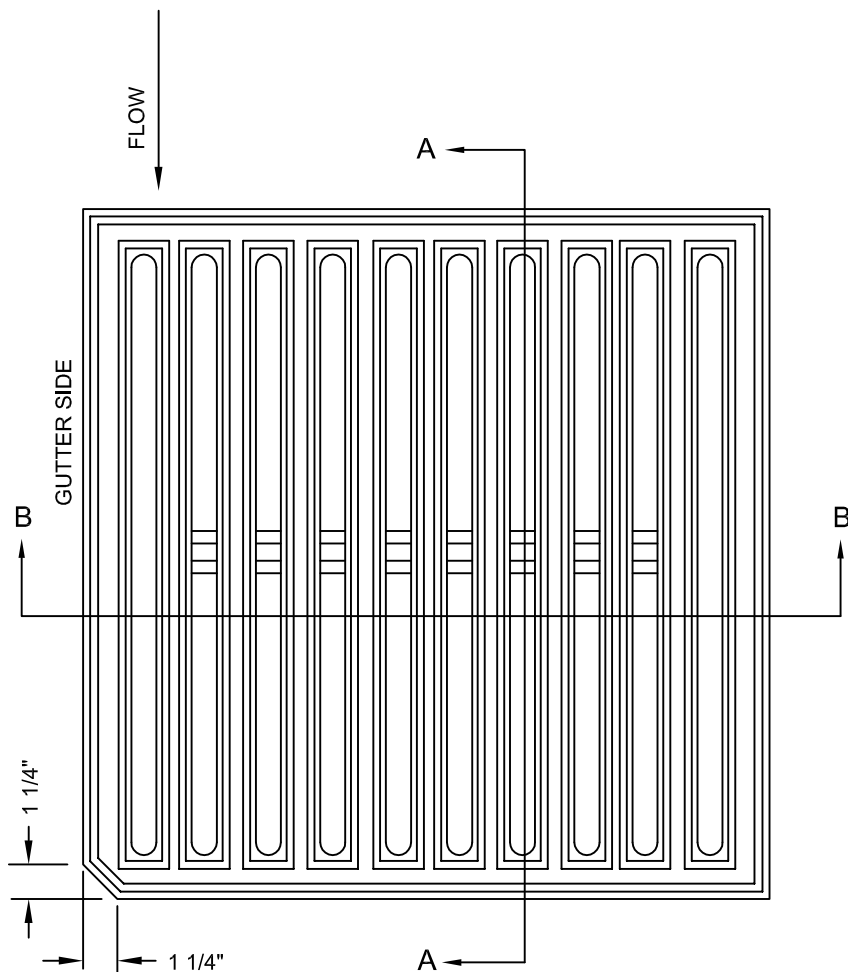
NOTE: SEAT SURFACES ON BOTH FRAME AND  
GRATE ARE MACHINED AND GRATE MUST NOT  
ROCK IN FRAME WHEN ASSEMBLED.

*Tumbler should be set at 1 1/4" below  
machined grate seat for installation.*

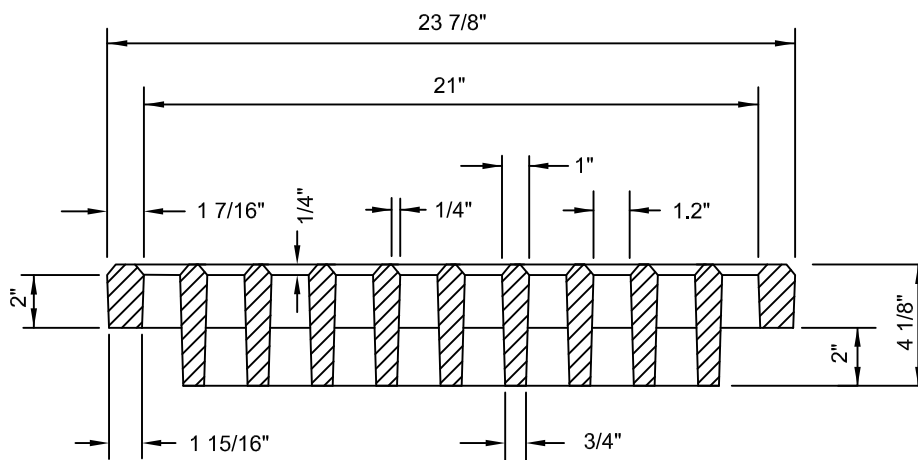
*Once grate is set in frame, torque bolt  
1/4 turn past snug.*

**WEIGHTS:**

3-FLANGE FRAME	240 LBS. MIN
4-FLANGE FRAME	270 LBS. MIN
A-4 GRATE	205 LBS. MIN



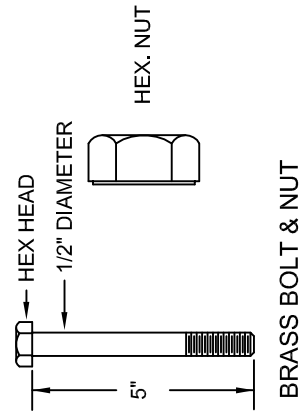
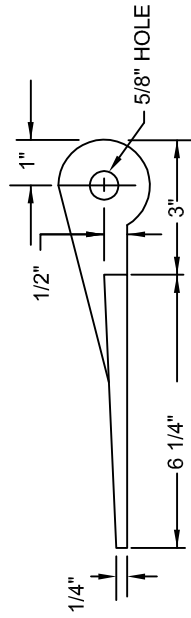
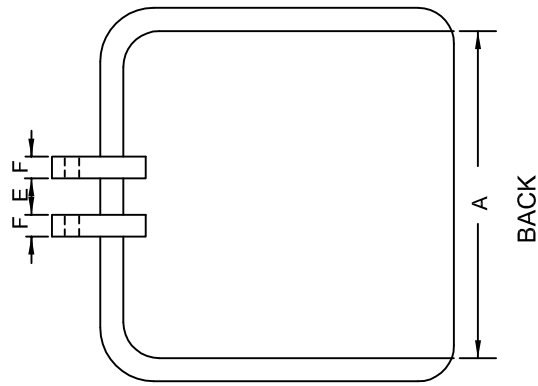
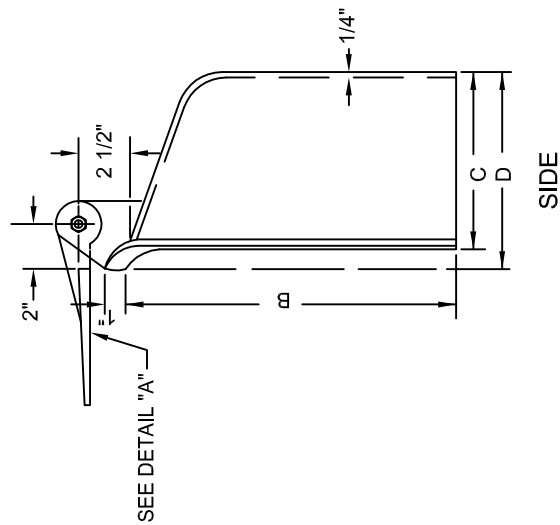
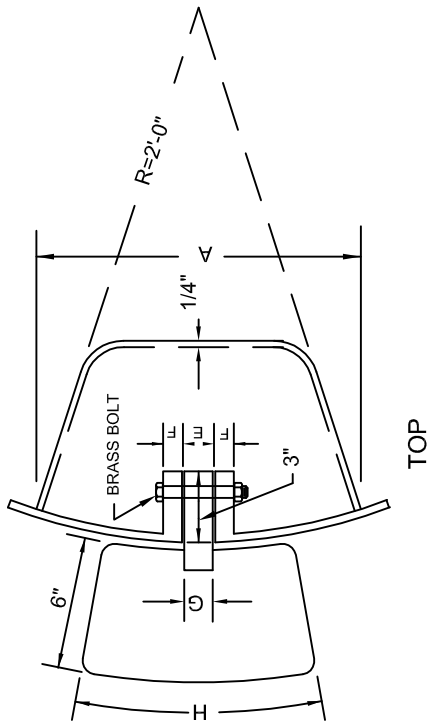
**SECTION A-A**



**SECTION B-B**

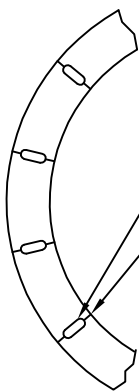
**NOTES:**

1. MATERIAL - CAST IRON; SEE STANDARD SPECIFICATIONS
2. MINIMUM MASS - 210 LBS.



DIMENSIONS (in.)	A	B	C	D	E	F	G	H
8" and 10" PIPE	15	15	8	9	2	7/8	1 7/8	14
12" and 15" PIPE	18	18	10	11 1/4	2	1	1 7/8	14

NOTE:  
1. HOODS TO BE GRAY CAST IRON - SEE STANDARD SPECIFICATIONS  
WITH NO BLACK ASPHALT COATING ALLOWED



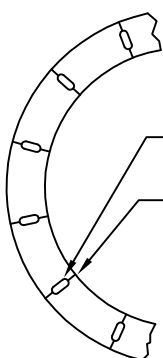
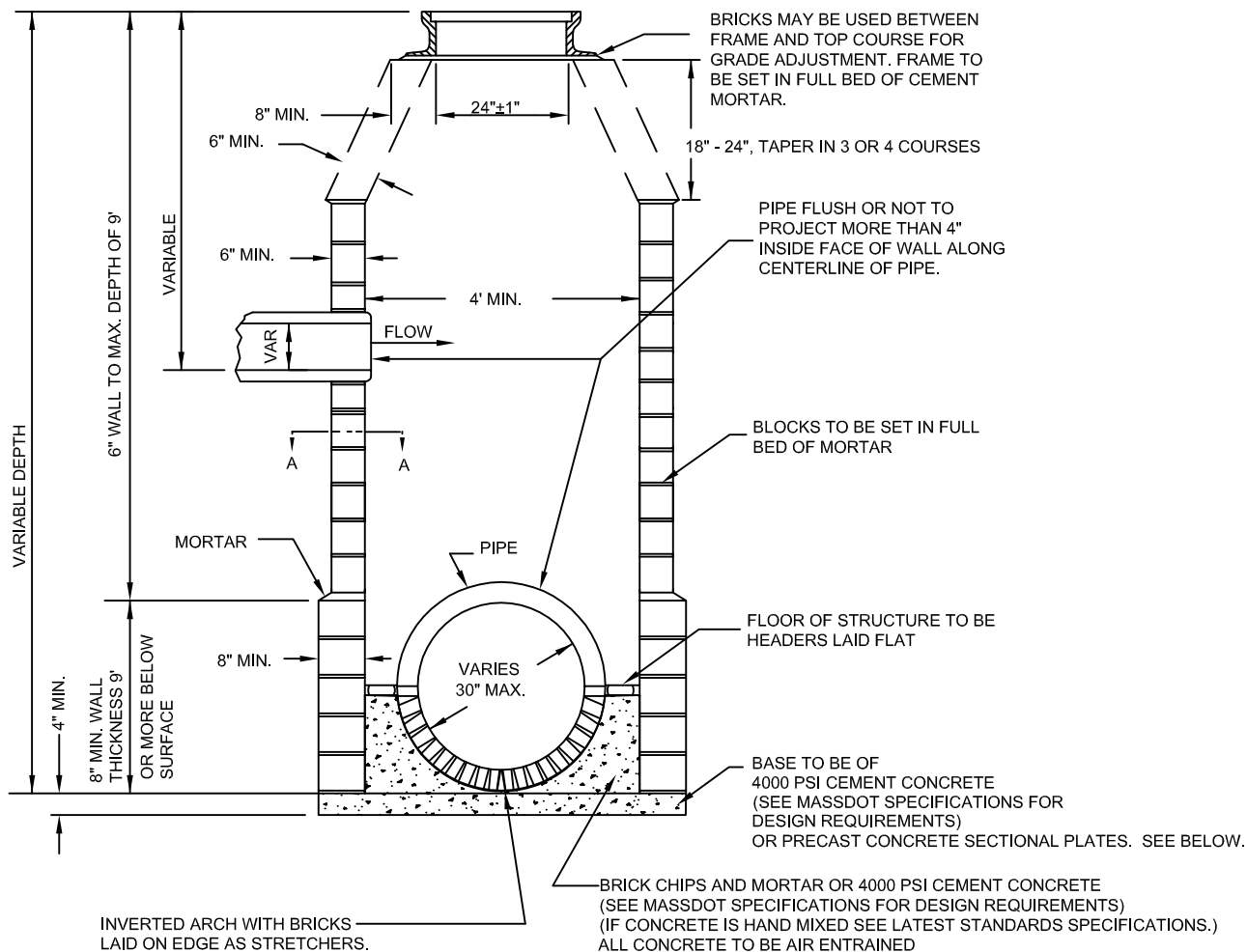
3'-4" MIN.

4" SECTIONAL PLATES

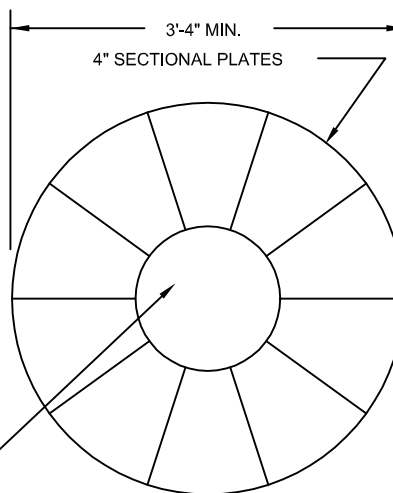
7

SOLID SECTION; OR FILL HOLE WITH BRICKS AND MORTAR;  
OR FILL WITH 4000 PSI CEMENT CONCRETE  
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)  
(IF CONCRETE IS HAND MIXED SEE LATEST STANDARD SPECIFICATIONS)

1. DESIGN SHOWN IS FOR MANHOLE OF 9' OR LESS AND PIPE DIAMETER OF 30" OR LESS.
2. STANDARD MANHOLE DEPTH TO BE 6'-6" OR LESS



SECTION A-A

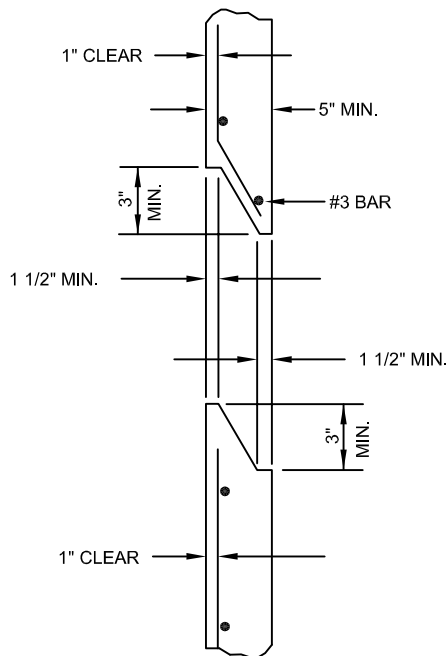
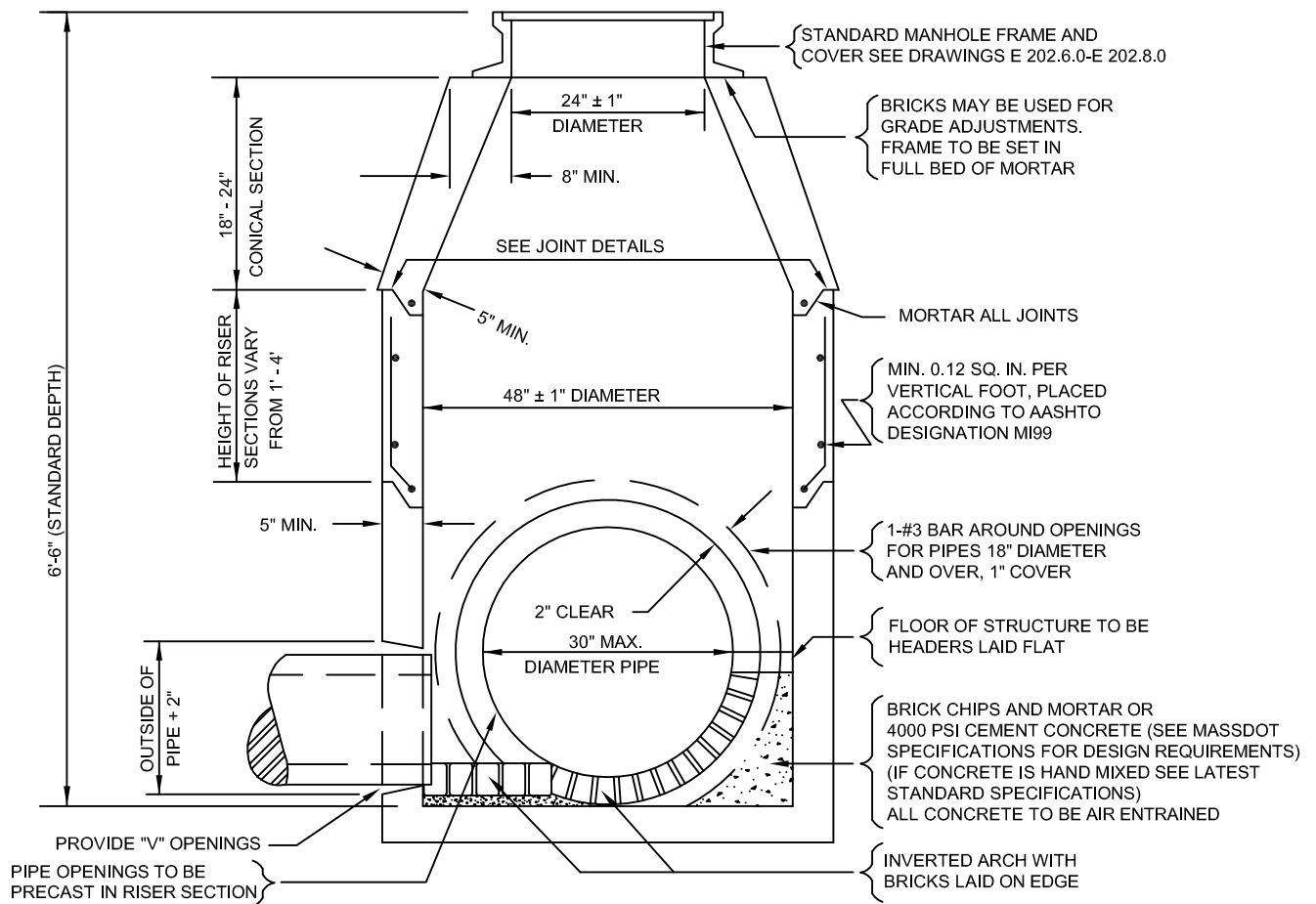


PLAN OF BASE

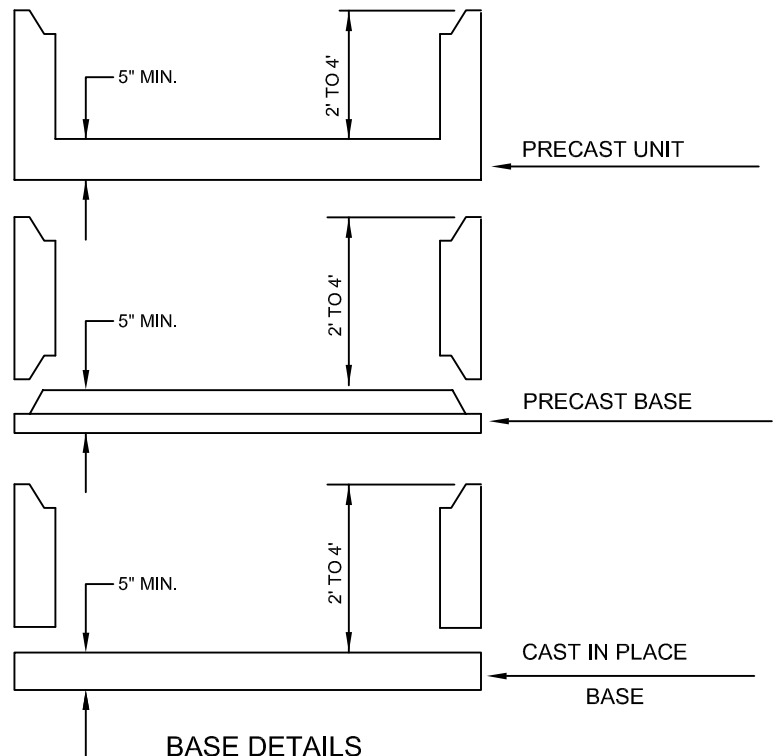
SOLID SECTION; OR FILL HOLE WITH BRICKS AND MORTAR;  
OR FILL WITH 4000 PSI CEMENT CONCRETE  
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)  
(IF CONCRETE IS HAND MIXED SEE LATEST STANDARD SPECIFICATIONS)

NOTE:

1. MANHOLE DESIGN IS FOR PIPE DIAMETER OF 30" OR LESS



JOINT DETAILS



BASE DETAILS

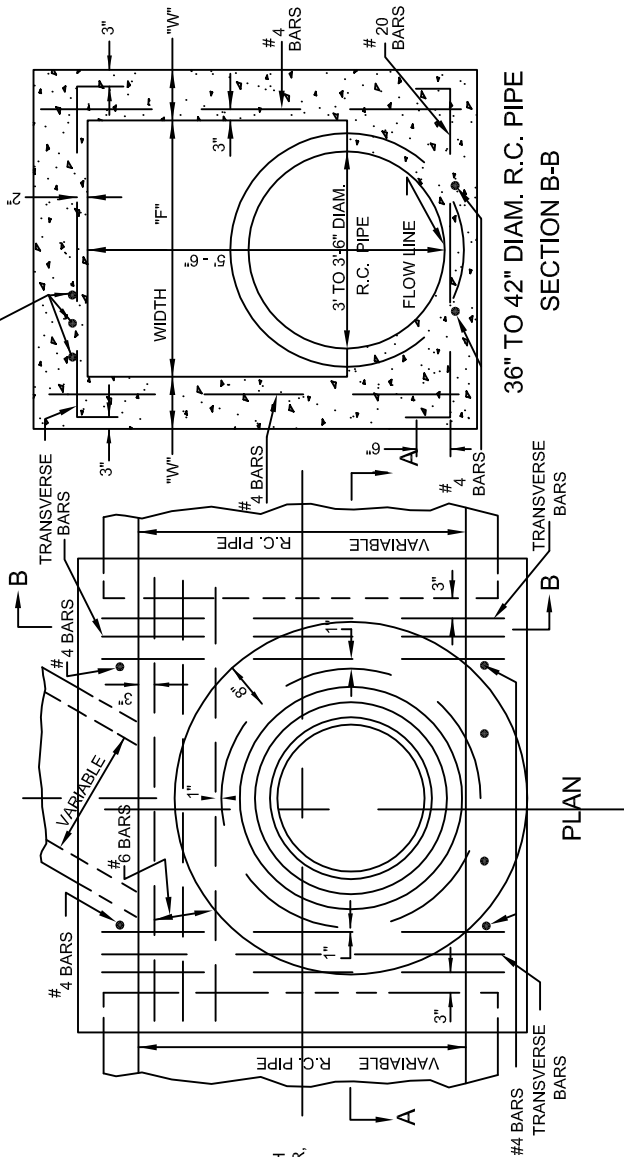
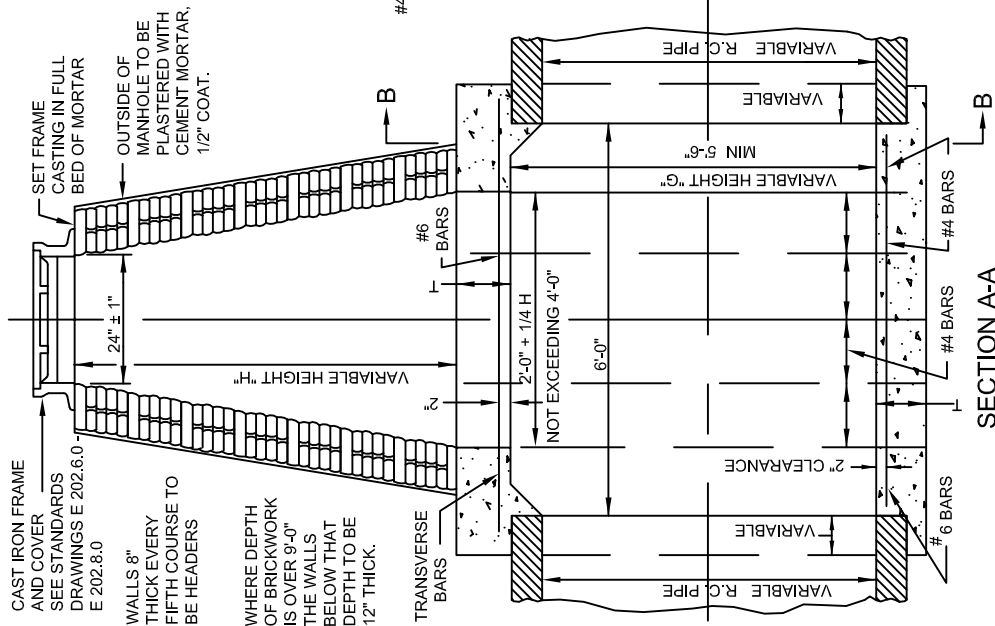
NOTE:

1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.

# **SPECIAL MANHOLES FOR 36" TO 84" DIAMETER R.C. PIPE**

DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 202.5.0**

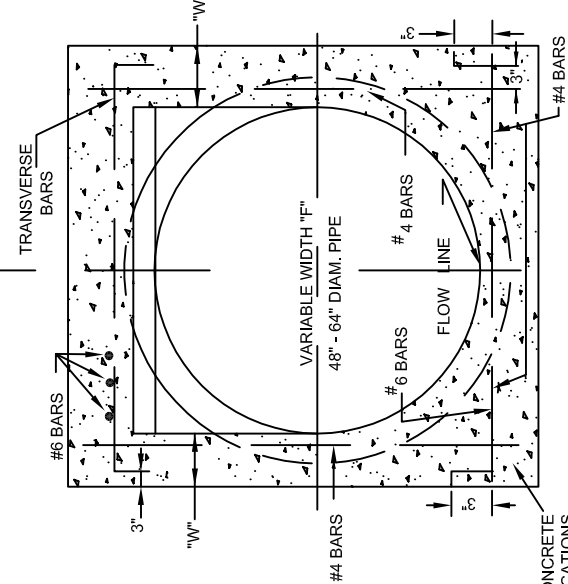


TOP AND BOTTOM SLABS & SIDEWALLS TO BE CLASS "B" CONC.

SIZE OF PIPE	WIDTH "F"	HEIGHT "G"	HEIGHT "H"							
			8.0'-15.9'		16.0'-23.9'		24.0'&UP			
			T	W	T	W	T	W		
36"	4'-0"	5'-6"	8"	10"	8"	12"	9"	12"		
42"	4'-0"	5'-6"	8"	10"	8"	12"	9"	12"		
48"	4'-0"	5'-6"	8"	10"	8"	12"	9"	12"		
54"	4'-6"	5'-6"	8"	10"	8"	12"	10"	12"		
60"	5'-0"	5'-6"	8"	10"	9"	12"	11"	12"		
72"	6'-0"	6'-0"	9"	10"	10"	12"	12"	12"		
84"	7'-0"	7'-0"	10"	10"	11"	12"	13"	12"		

SIZE NUMBER AND SPACING OF BARS.

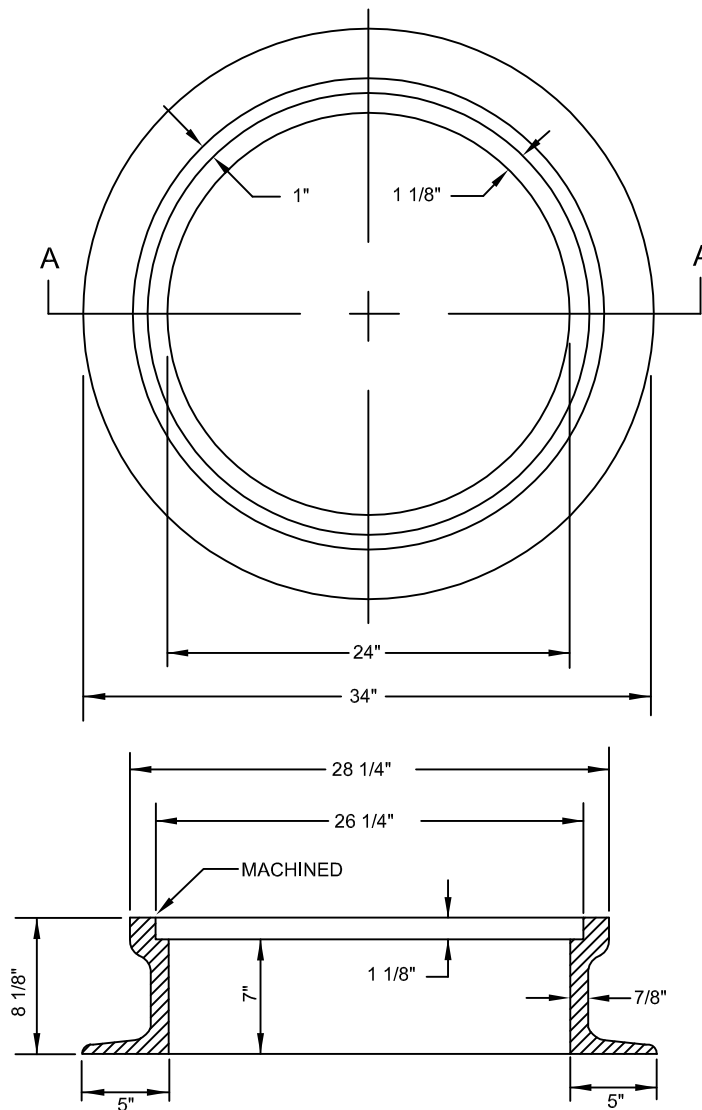
T	TOP SLAB		BOTTOM SLAB		SIDEWALLS
	TRANS. BARS	LONG BARS	TRANS. BARS	LONG BARS	
8"	6-#7	3-#6	6 1/2" OC	24" OC	12" OC
9"	6-#7	3-#6	5 1/2" OC	DO	DO
10"	6-#8	3-#6	5" OC	DO	DO
11"	6-#8	3-#6	4 1/2" OC	DO	DO
12"	6-#9	3-#6	4" OC	DO	DO
13"	6-#10	3-#6	4" OC	DO	DO



48" TO 84" DIAM. R.C. PIPE SECTION B-B

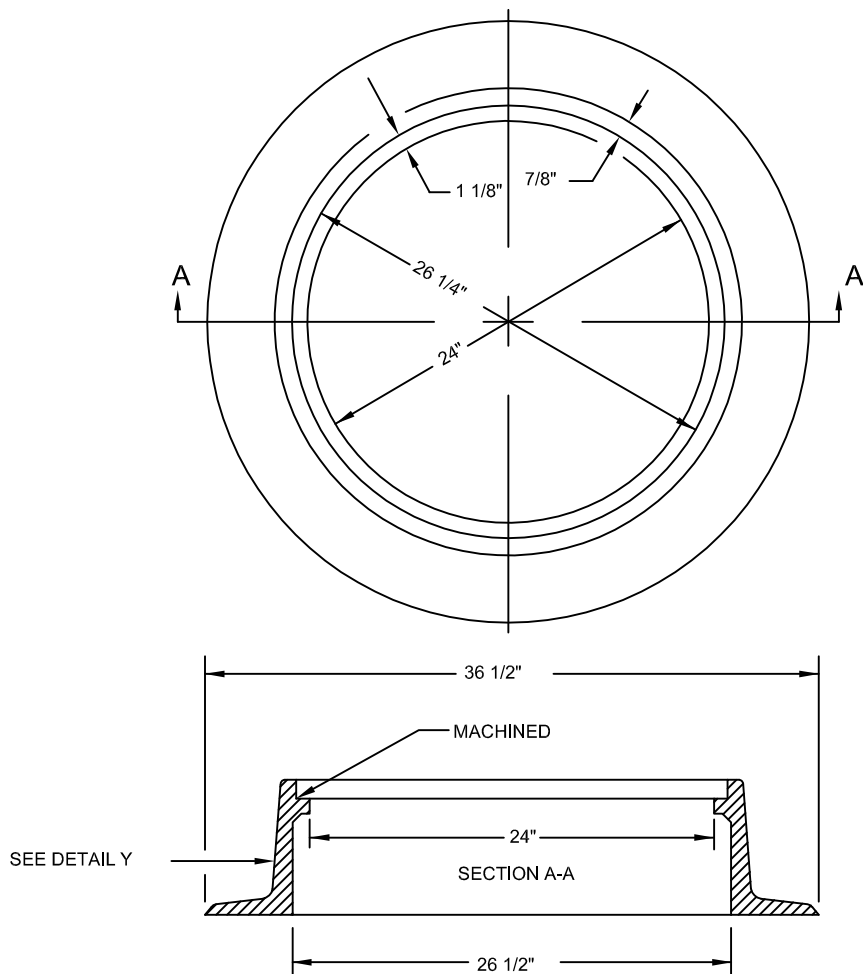


STANDARD COVER  
FOR COVER DETAILS SEE DRAWING E 202.8.0

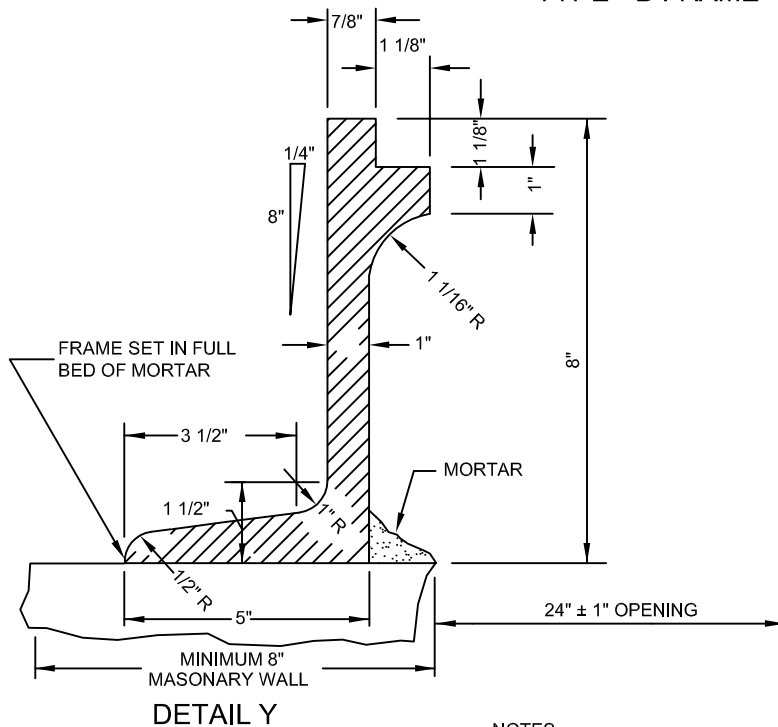


NOTES:

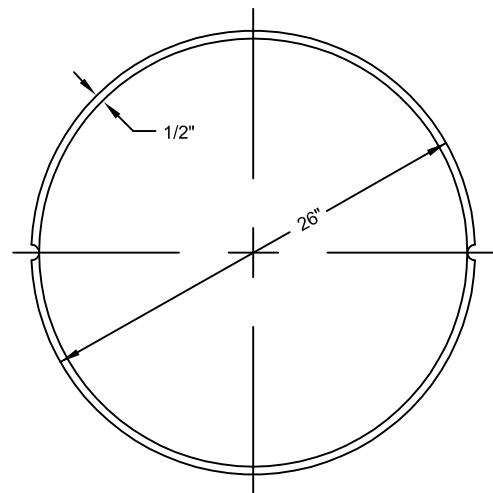
1. MINIMUM MASS - 265 LBS.
2. MATERIAL - CAST IRON - SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED



TYPE - B FRAME



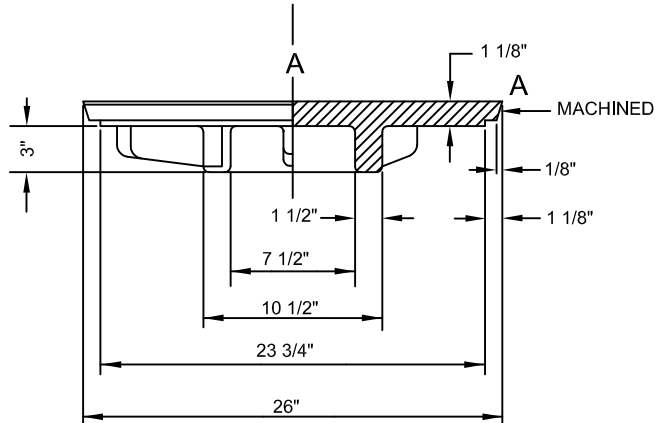
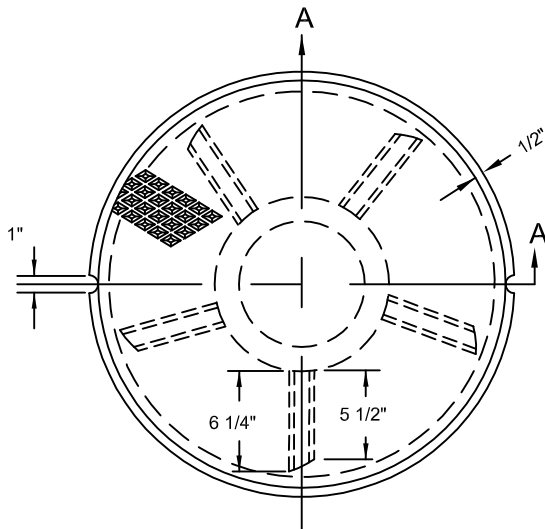
DETAIL Y



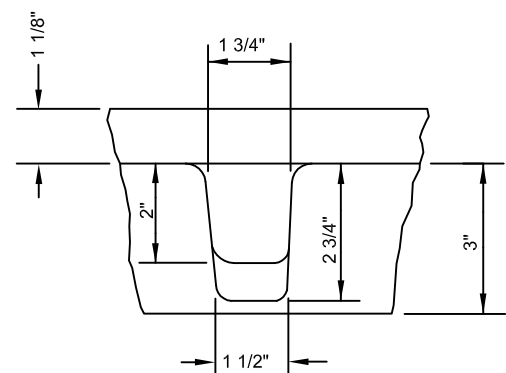
STANDARD COVER  
FOR COVER DETAIL, SEE DRAWING E 202.8.0

**NOTES:**

1. MINIMUM FRAME MASS 265 LBS.
2. MATERIAL - CAST IRON - SEE STANDARD SPECIFICATIONS  
WITH NO BLACK ASPHALT COATING ALLOWED



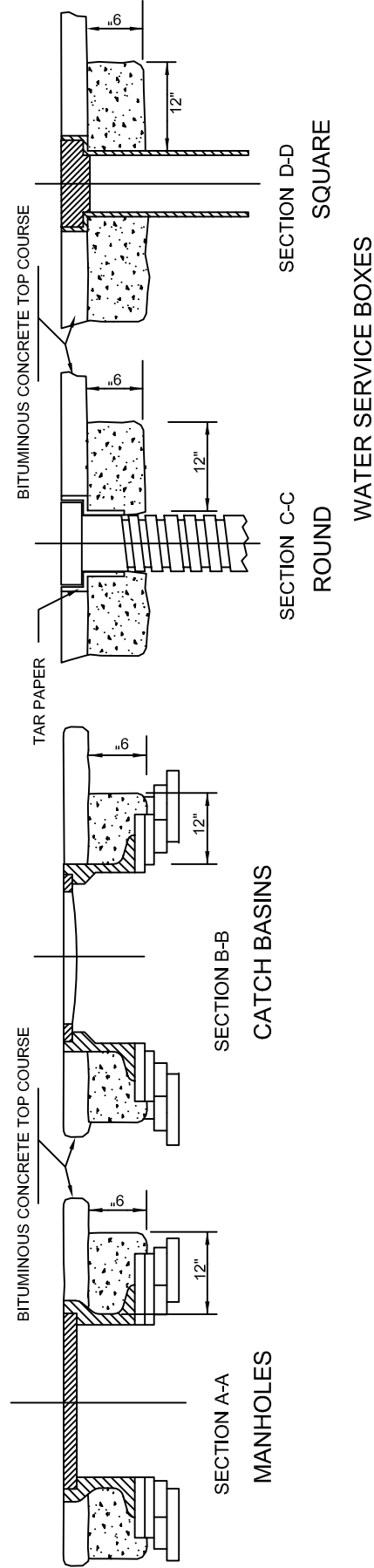
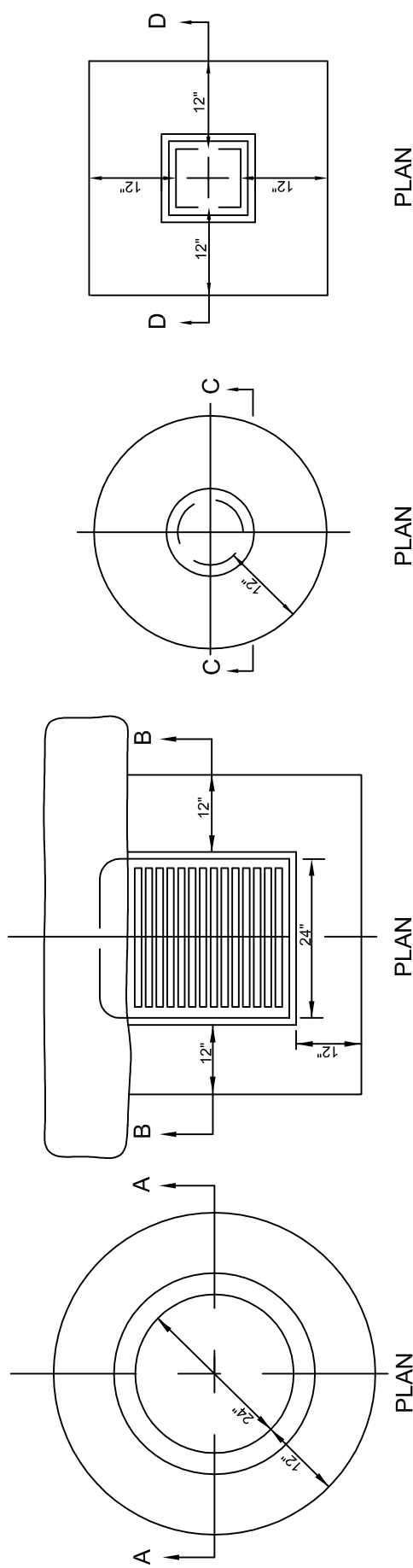
## MANHOLE COVER FOR TYPE A & B FRAMES



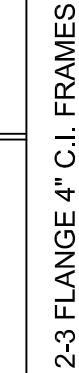
### DETAIL OF FIN

1. MINIMUM COVER MASS - 200 LBS.
2. MATERIAL - CAST IRON - SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED

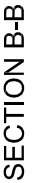
# CONCRETE COLLARS



- NOTES:
1. COLLARS TO BE 4000PSI CEMENT CONCRETE MASONRY REGULAR OR H.E.S. AS DIRECTED. (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS). (IF HAND MIXED, SEE LATEST STANDARD SPECIFICATIONS).
  2. NO CONCRETE REQUIRED IN CONCRETE PAVEMENT.



1. COLLARS TO BE 4000PSI CEMENT CONCRETE MASONRY REGULAR OR H.E.S. AS DIRECTED.  
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS).



NOTES:

1. STANDARD PARALLEL BAR GRATES TO BE USED. SEE DETAILS ON DRAWINGS E 201.10.0
2. MINIMUM C.I. FRAME MASS - 205 LBS. EACH
3. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS SEE LATEST STANDARD SPECIFICATIONS

TYPE "A"

4. 4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS).

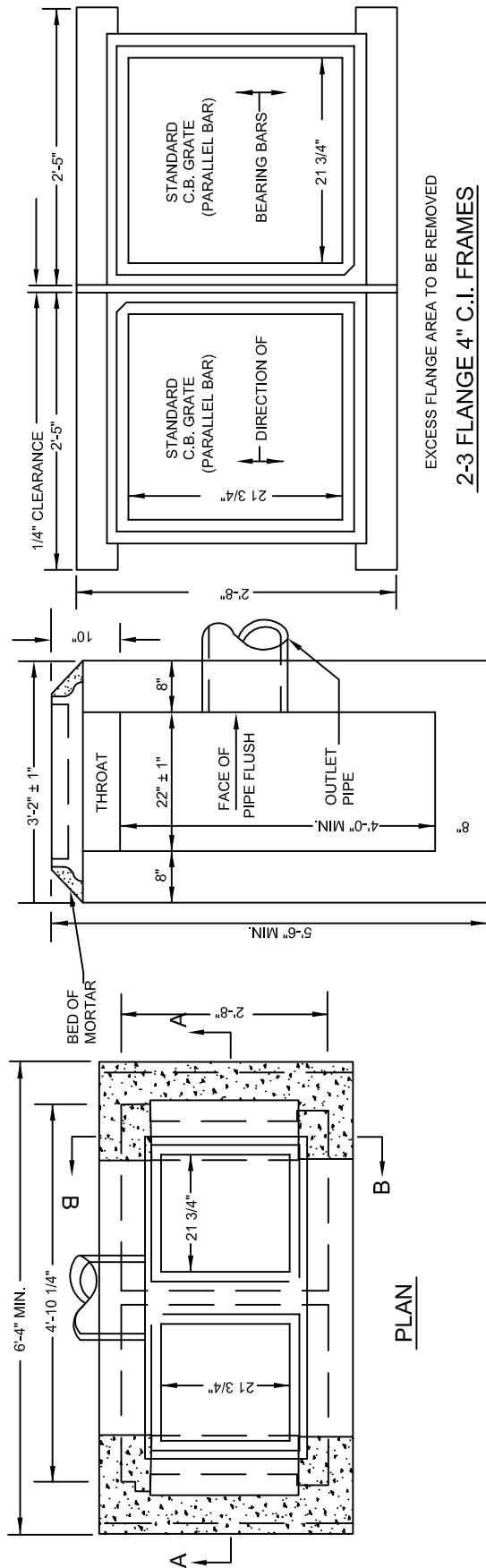
TYPE "B"

- 5. NOMINAL CONCRETE BLOCK DIMENSIONS**  
**HEIGHT, 4" TO 8"**

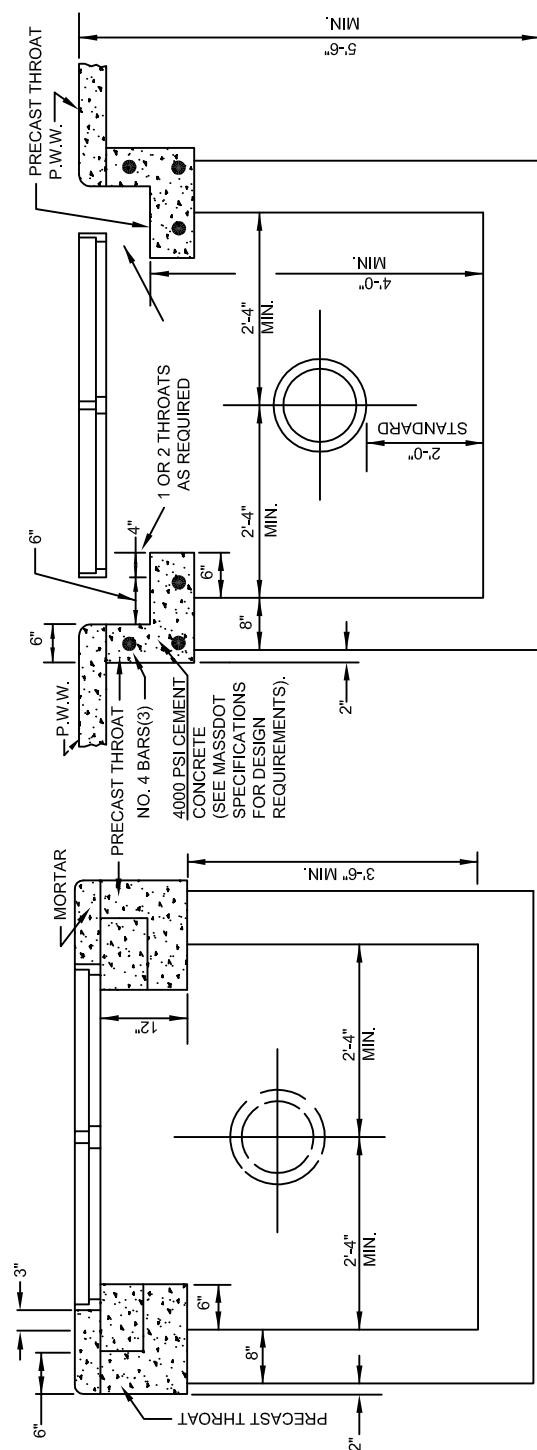
- WIDTH, 8"  
LENGTH, 8" TO 16"

6. BLOCKS TO BE SET IN FULL BED OF MORTAR  
7. THIS DROP INLET IS NOT TO BE USED AT ANY LOCATION WHERE IT MAY PRESENT A HAZARD TO VEHICLES THAT RUN OFF THE ROAD.  
FOR FLUSH TYPE SEE DRAWING E 203.2.0

# **DROP INLETS** **TYPE AF - PRECAST CONCRETE** **TYPE BF - CONCRETE BLOCK**



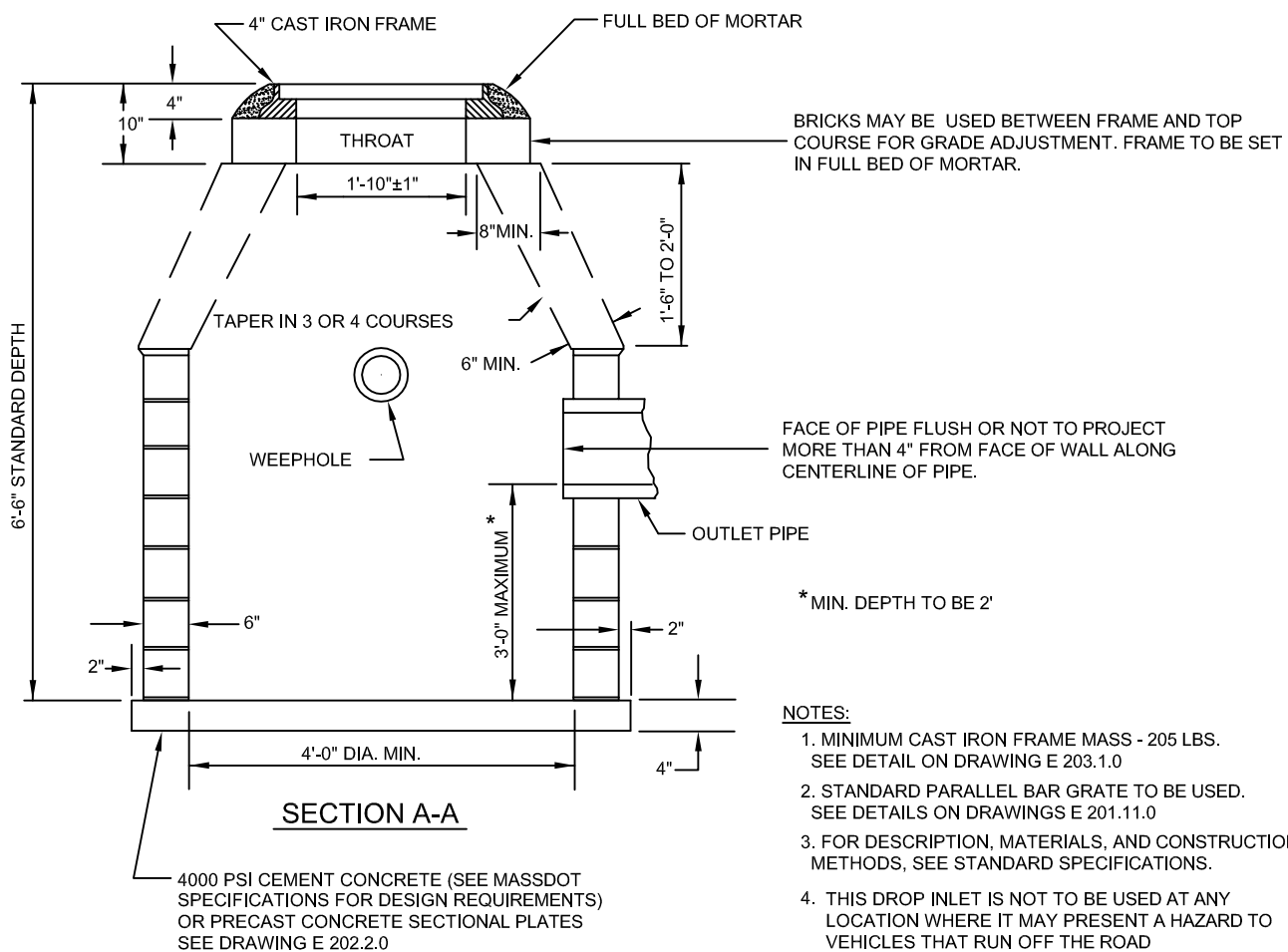
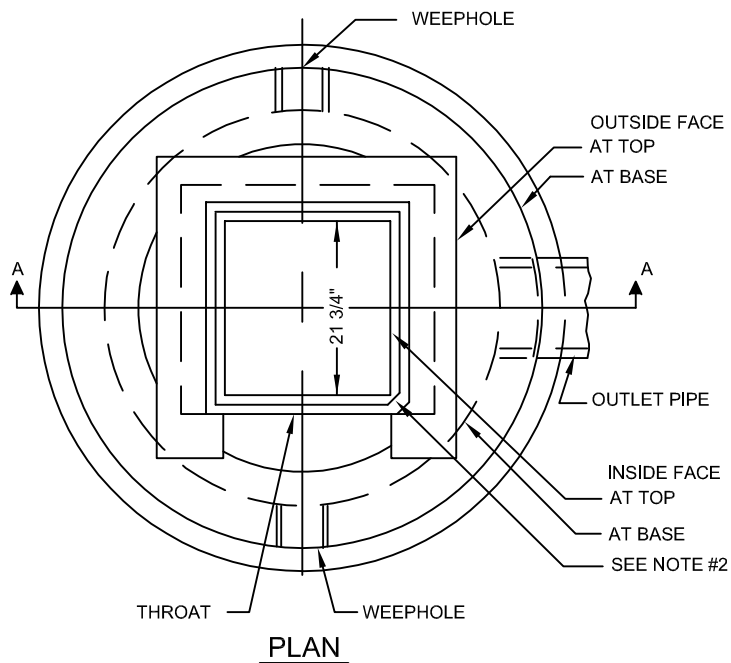
SECTION B-B



ELEVATION

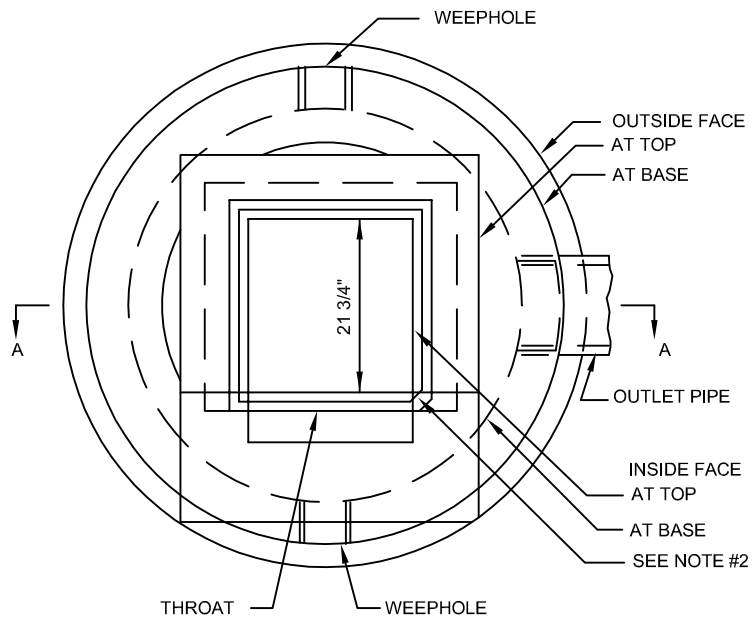
SECTION A-A

- NOTES:
1. FOR DETAILS OF PRECAST THROAT SEE DRAWING E 203.7.0
  2. SEE DRAWING 203.1.0 FOR DETAILS NOT SHOWN

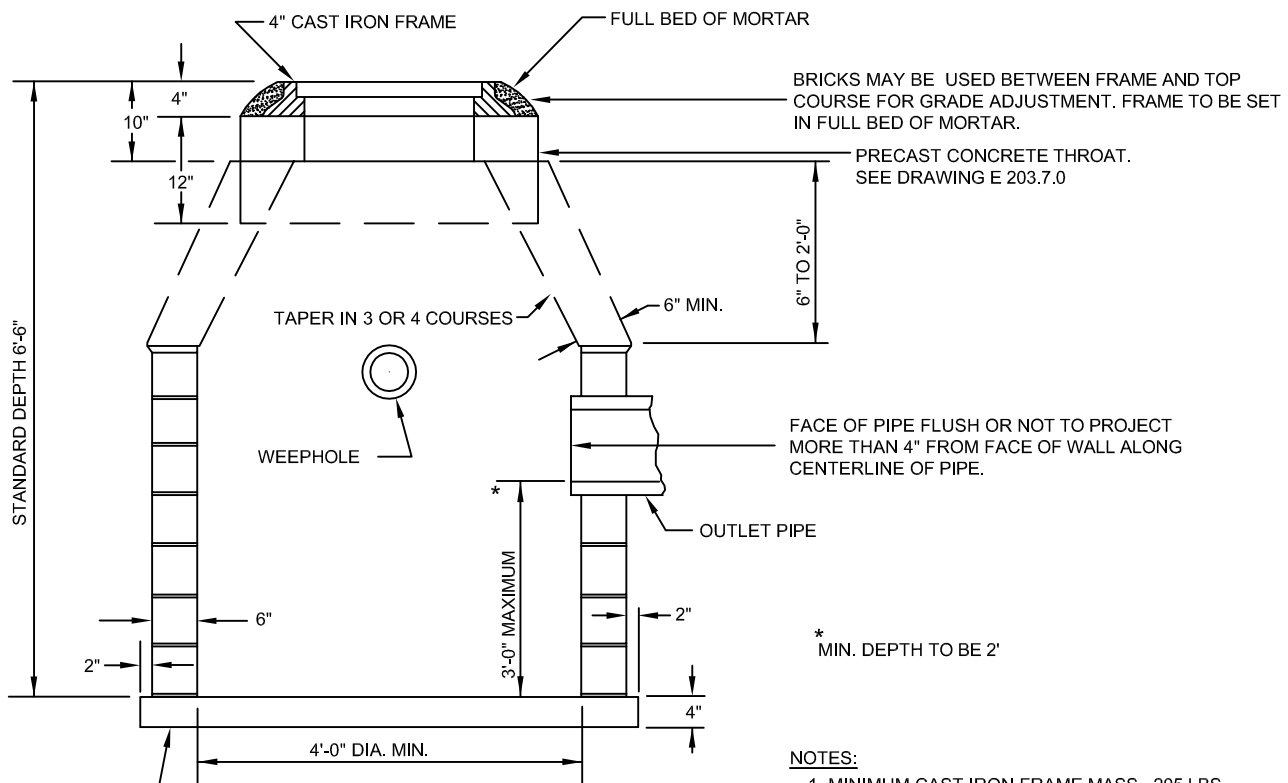


**NOTES:**

1. MINIMUM CAST IRON FRAME MASS - 205 LBS. SEE DETAIL ON DRAWING E 203.1.0
2. STANDARD PARALLEL BAR GRATE TO BE USED. SEE DETAILS ON DRAWINGS E 201.11.0
3. FOR DESCRIPTION, MATERIALS, AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
4. THIS DROP INLET IS NOT TO BE USED AT ANY LOCATION WHERE IT MAY PRESENT A HAZARD TO VEHICLES THAT RUN OFF THE ROAD FOR FLUSH TYPE SEE DRAWING E 203.4.0
5. SEE DRAWING E 201.3.0 CONCRETE BLOCK CATCH BASIN FOR DETAILS



**PLAN**



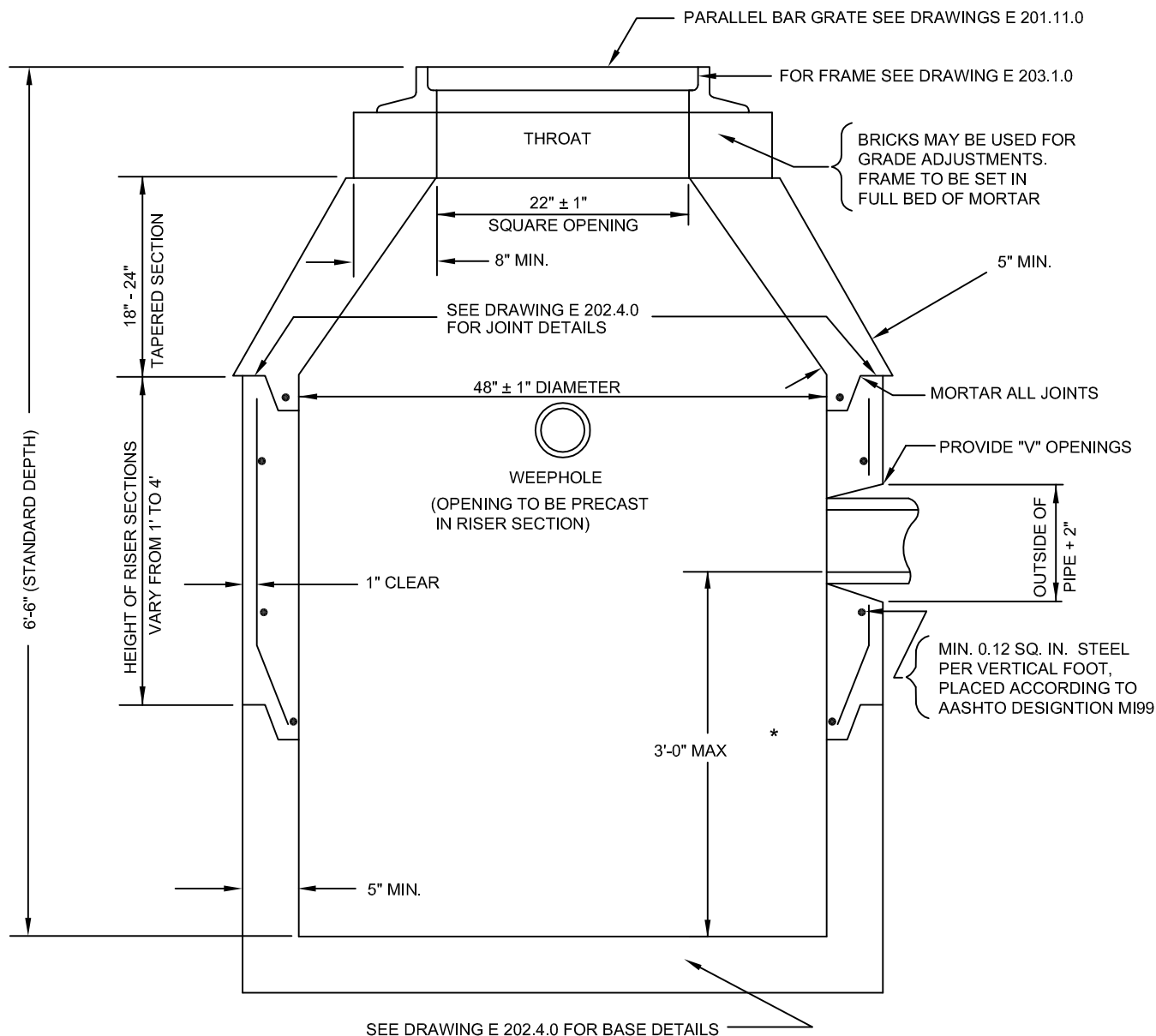
**SECTION A-A**

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) OR PRECAST CONCRETE SECTIONAL PLATES SEE DRAWING E 201.3.0

**NOTES:**

1. MINIMUM CAST IRON FRAME MASS - 205 LBS. SEE DETAIL ON DRAWING E 203.1.0
2. STANDARD PARALLEL BAR GRATE TO BE USED. SEE DETAILS DRAWINGS E 201.11.0
3. FOR DESCRIPTION, MATERIALS, AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
4. TO BE USED IN MEDIANS AND DITCHES THAT ARE WITHIN THE RECOVERY AREA.
5. SEE DRAWING E 201.3.0 CONCRETE BLOCK CATCH BASIN FOR DETAILS

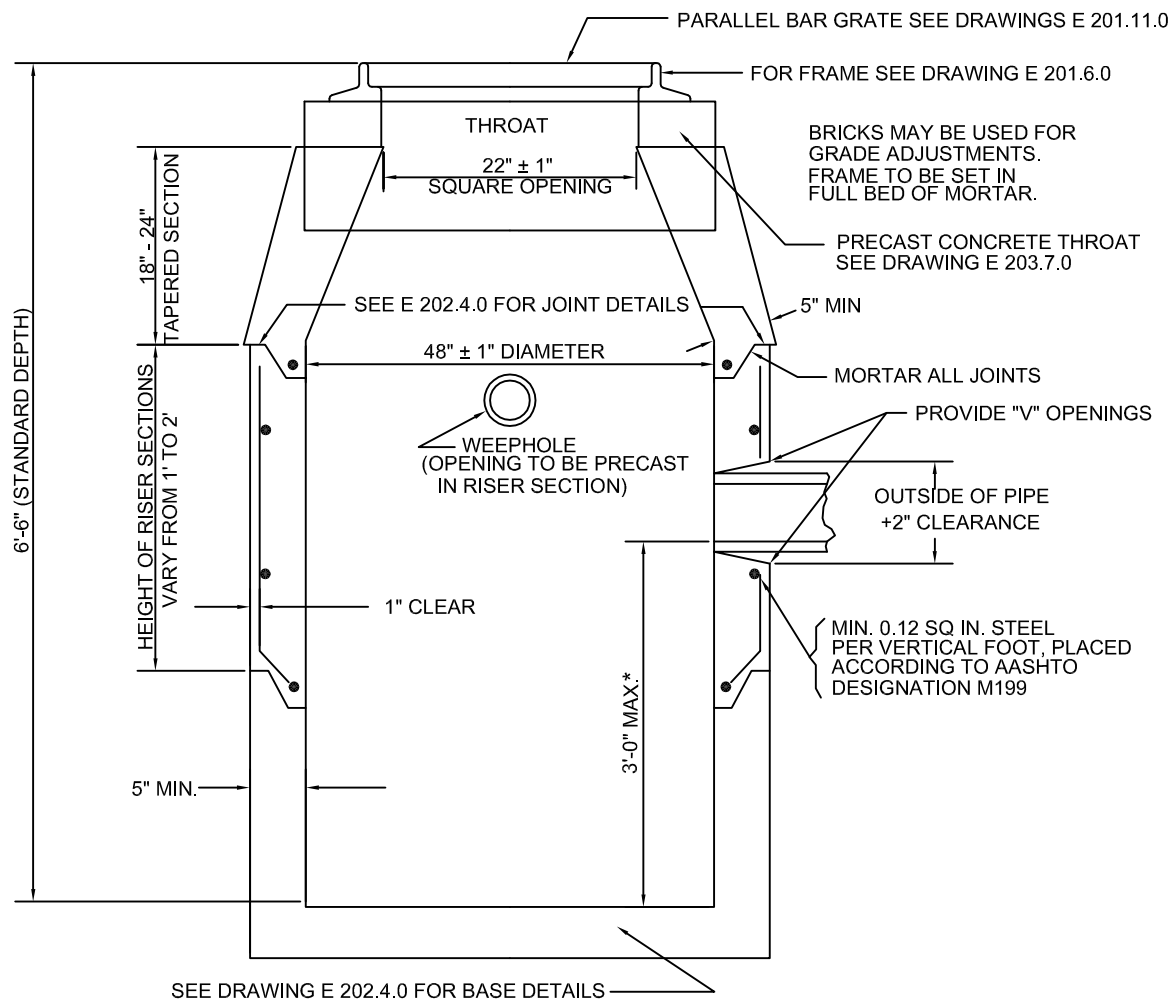




\* MINIMUM DEPTH OF SUMP TO BE 2'

NOTES:

1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON DRAWING E 203.3.0
2. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHOD, SEE LATEST STANDARD SPECIFICATIONS
3. THIS DROP INLET IS NOT TO BE USED AT ANY LOCATION WHERE IT MAY PRESENT A HAZARD TO VEHICLES THAT RUN OFF THE ROAD. FOR FLUSH TYPE SEE DRAWING E 203.6.0

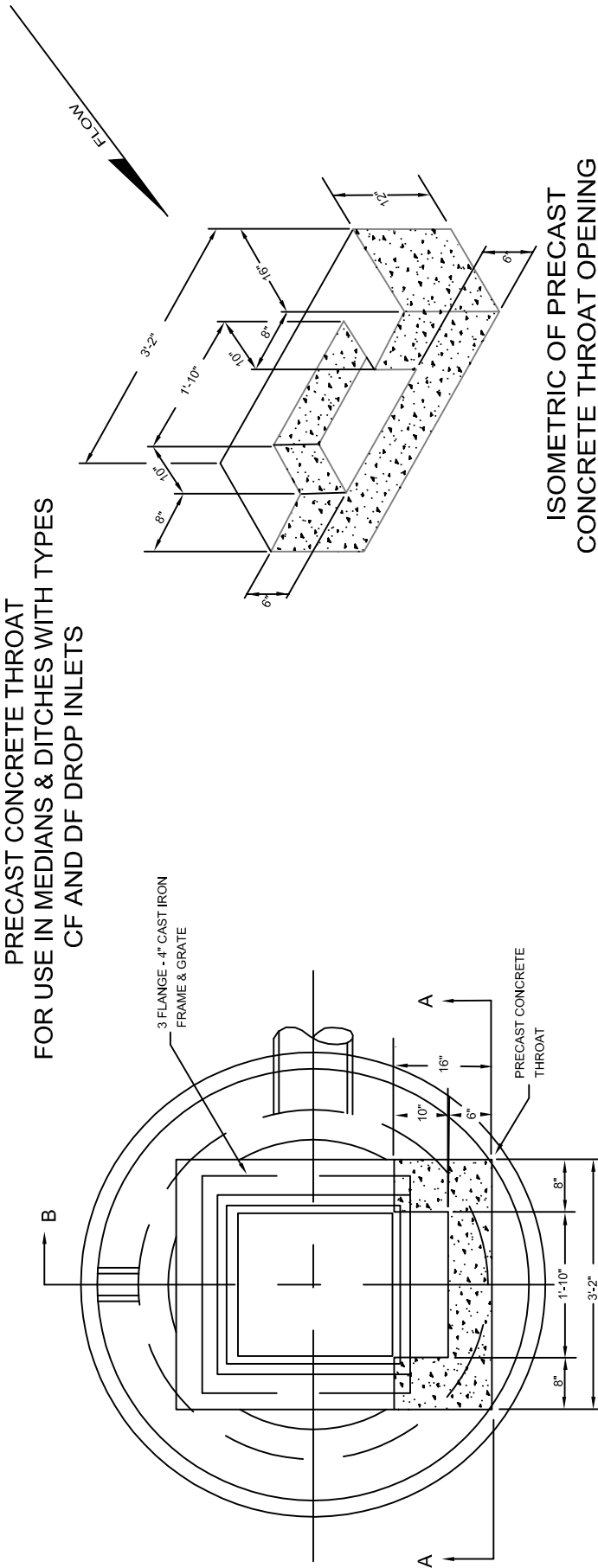


\* MINIMUM DEPTH OF SUMP TO BE 2'

#### NOTES:

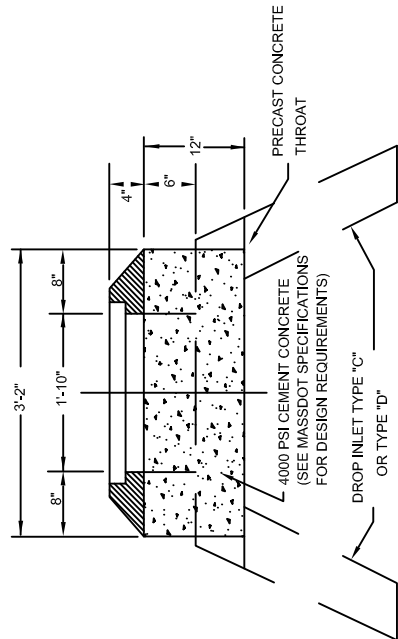
1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON DRAWINGS E 203.3.0 AND E 203.4.0
2. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHOD, SEE LATEST STANDARD SPECIFICATIONS
3. TO BE USED IN MEDIANS AND DITCHES THAT ARE WITHIN THE RECOVERY AREA

**PRECAST CONCRETE THROAT  
FOR USE IN MEDIANS & DITCHES WITH TYPES  
CF AND DF DROP INLETS**

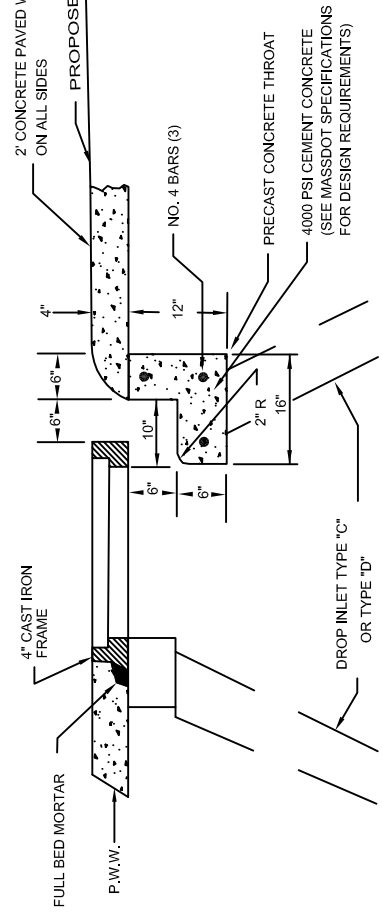


**ISOMETRIC OF PRECAST  
CONCRETE THROAT OPENING**

**PLAN**



**SECTION A-A**



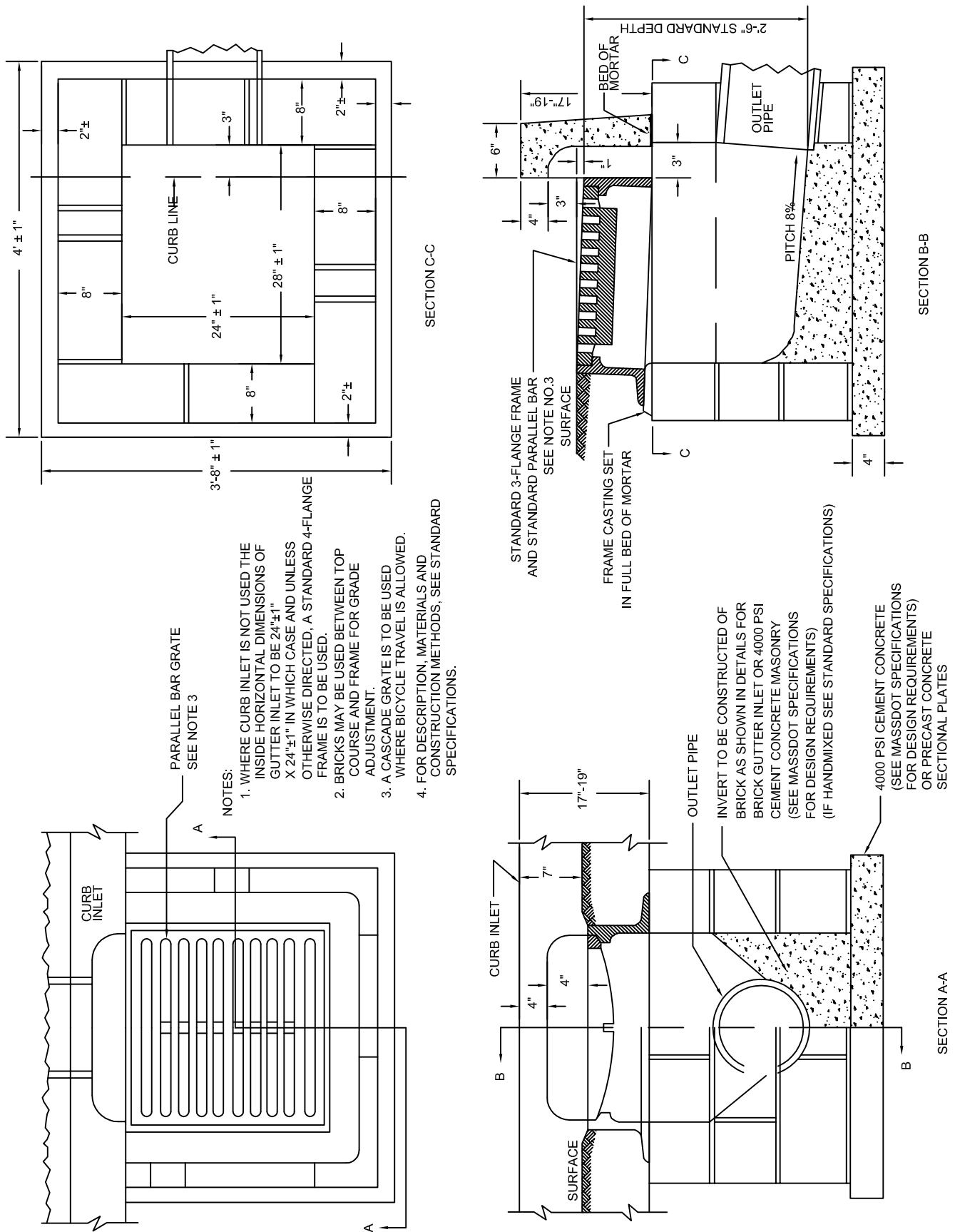
**SECTION B-B**

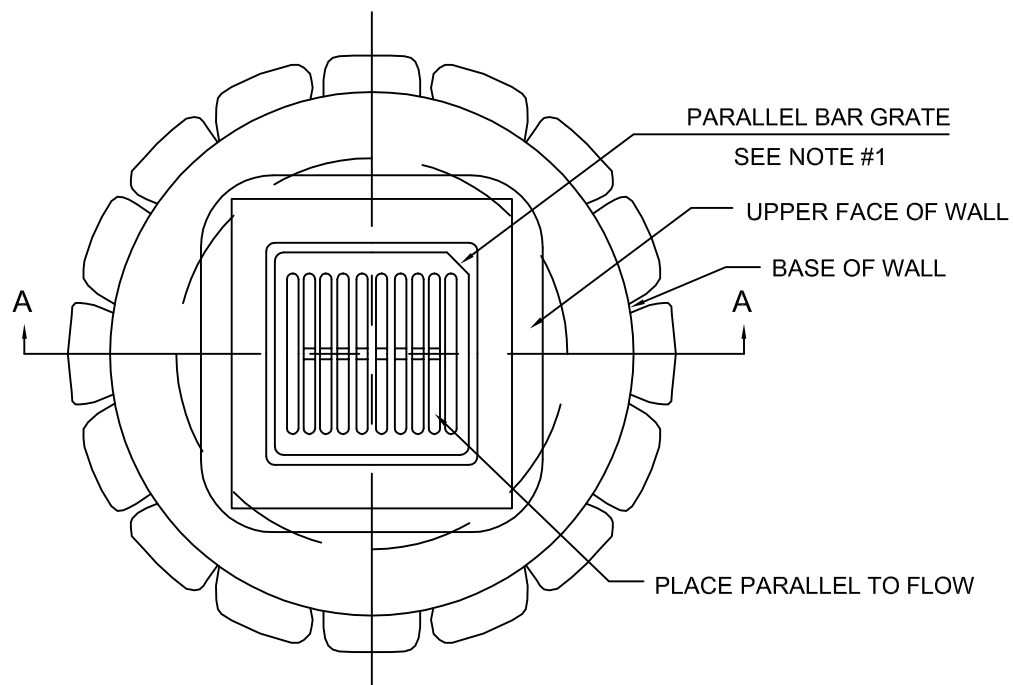
**FLUSH DROP INLET  
THROAT**

DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 203.7.0**

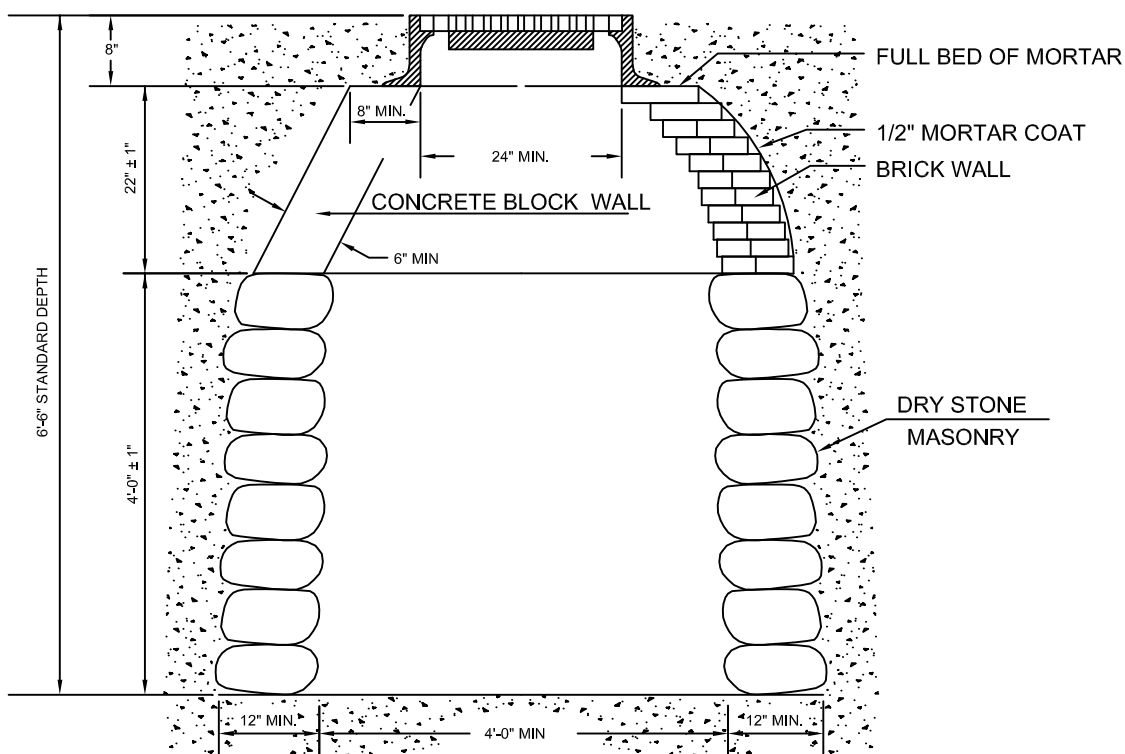
# GUTTER INLET





**NOTES:**

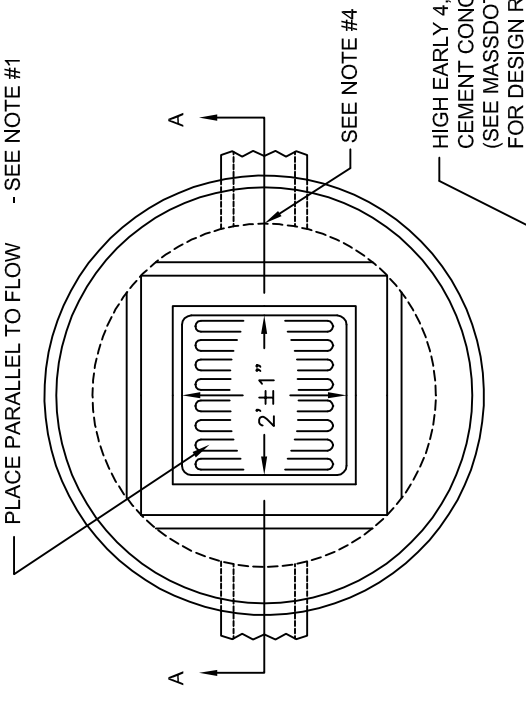
1. USE CASCADE GRATE WHERE BICYCLE TRAVEL IS LEGALLY ALLOWED. SEE DRAWINGS E 201.7.0 - E 201.9.0
2. BRICK WALL TO BE 8" THICK; EVERY FIFTH COURSE TO BE HEADERS; OUTSIDE TO BE FINISHED WITH CEMENT MORTAR COATING.
3. WHEN USING CONCRETE BLOCKS, BLOCKS TO BE SET IN FULL BED OF MORTAR AND TAPERED IN 3 OR 4 COURSES.
4. BACKFILL FOR FULL DEPTH OF BASIN EXCAVATION TO BE GRAVEL.
5. FOR DESCRIPTION, MATERIALS AND METHOD OF CONSTRUCTION SEE STANDARD SPECIFICATIONS.



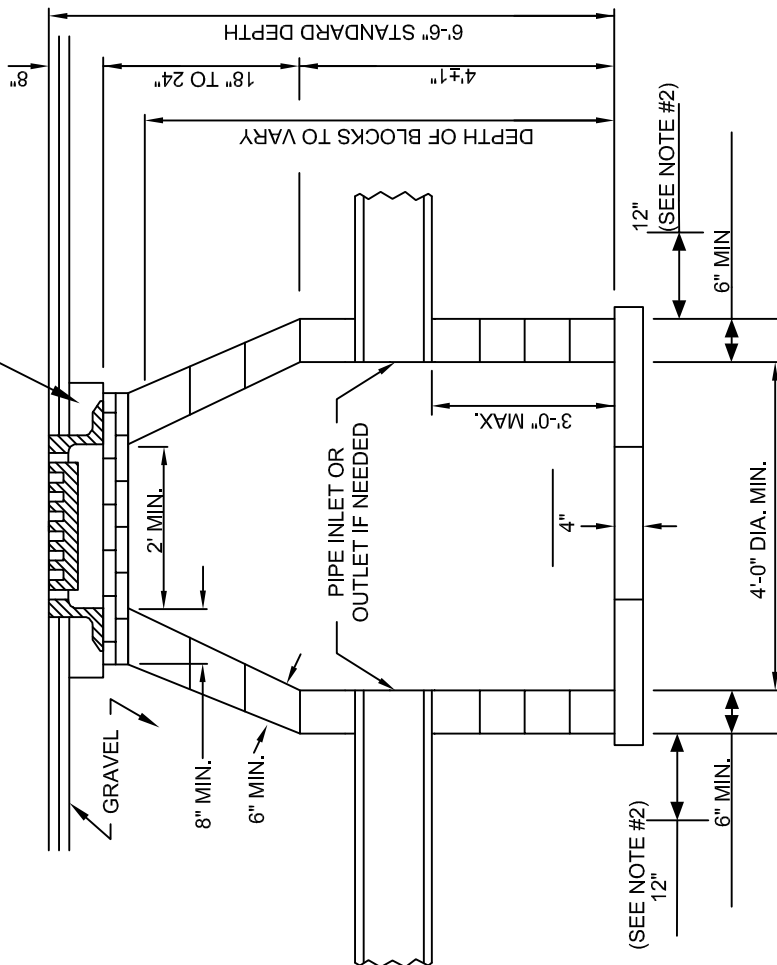
**SECTION A-A**

NOTES:

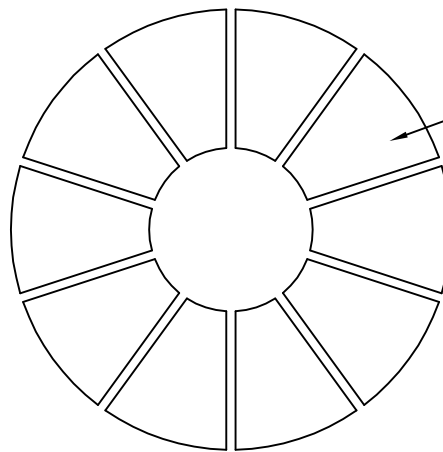
1. **USE CASCADE GRATE WHERE BICYCLE TRAVEL IS LEGALLY ALLOWED. SEE DRAWINGS E 201.7.0 - E 201.9.0.**
2. BACKFILL FOR FULL DEPTH OF BASIN EXCAVATION TO BE 1/2" CRUSHED STONE.
3. FOR DESCRIPTION, MATERIALS, AND METHOD OF CONSTRUCTION SEE STANDARD SPECIFICATIONS.
4. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL ALONG CENTERLINE OF PIPE.
5. THE LEACHING BASIN SHALL BE CONSTRUCTED OF CEMENT CONCRETE BLOCKS TO CONFORM TO THE REQUIREMENTS OF STANDARD SPECIFICATION SUBSECTION M4.05.1.



HIGH EARLY 4,000 PSI  
CEMENT CONCRETE COLLAR  
(SEE MASSDOT SPECIFICATIONS  
FOR DESIGN REQUIREMENTS)



## SECTION A-A



**BOTTOM PLATES REQUIRE  
10 PIECES PER CIRCLE WITH  
1/2" SPACING BETWEEN PLATES.  
4" THICK**

## CONCRETE BLOCK LEACHING BASIN

DATE OF ISSUE
OCTOBER 2017

DRAWING NUMBER  
**E 205.2.0**

# CORRUGATED STEEL METAL PIPE TABLE OF MINIMUM WALL THICKNESS

TABLE OF MINIMUM WALL THICKNESS (FT)  
(2 2/3" x 1/2" CORRUGATION)

HEIGHT OF COVER ABOVE TOP OF PIPE (FEET)											
DIA. (IN)	MIN. - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	38 - 40	41 - 45	46 - 50	51 - 55	56 - 60
15	16	16	16	16	16	16	16	16			
18	16	16	16	16	16	16	14	14	14		
21	16	16	16	16	16	16	14	14	14	12	
24	16	16	16	14	14	14	14	12	12	10	10
30	14	14	14	14	12	12	12	10	10	10	8
36	14	14	12	12	10	10	10	10	8	8	8
42	12	12	12	10	10	10	8	8	8	8	8
48	12	12	12	10	8	8	10	10	10	8	8
54	10	10	8	8	10	10	10	8	8		
60	8	10	10	10	8	8	8	8			
66	10	10	10	8	8	8	8				
72	8	8	8	8	8						

NOTES:  
1. ALL PIPE BELOW SOLID LINE TO BE SHOP STRUTTED AS PER STATE SPECIFICATIONS  
2. MINIMUM COVER IS TOP OF PIPE TO ROAD - 18" GRADE

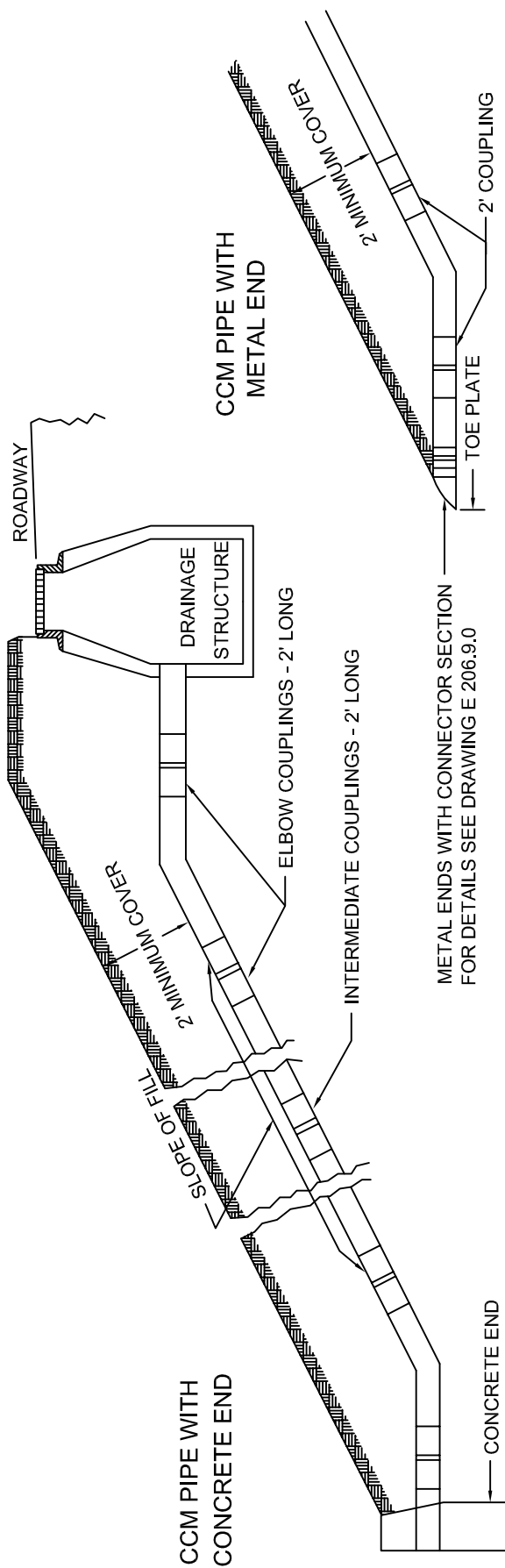
TABLE OF MINIMUM WALL THICKNESS (IN.)

MADE FROM PIPE OF DIA. (IN.)	SPAN (IN.)	RISE (IN.)	HEIGHT OF COVER ABOVE TOP OF PIPE ARCH (FEET)			
			MIN. - 3	4 - 5	6 - 10	11 - 15
15	18	11	16	16	16	16
18	22	13	16	16	16	16
24	29	18	14	14	14	14
30	36	22	14	14	14	14
36	43	27	12	12	12	12
42	50	31	12	12	12	12
48	58	36	10	12	12	10
54	65	40	10	10	10	8
60	72	44	8	8	8	

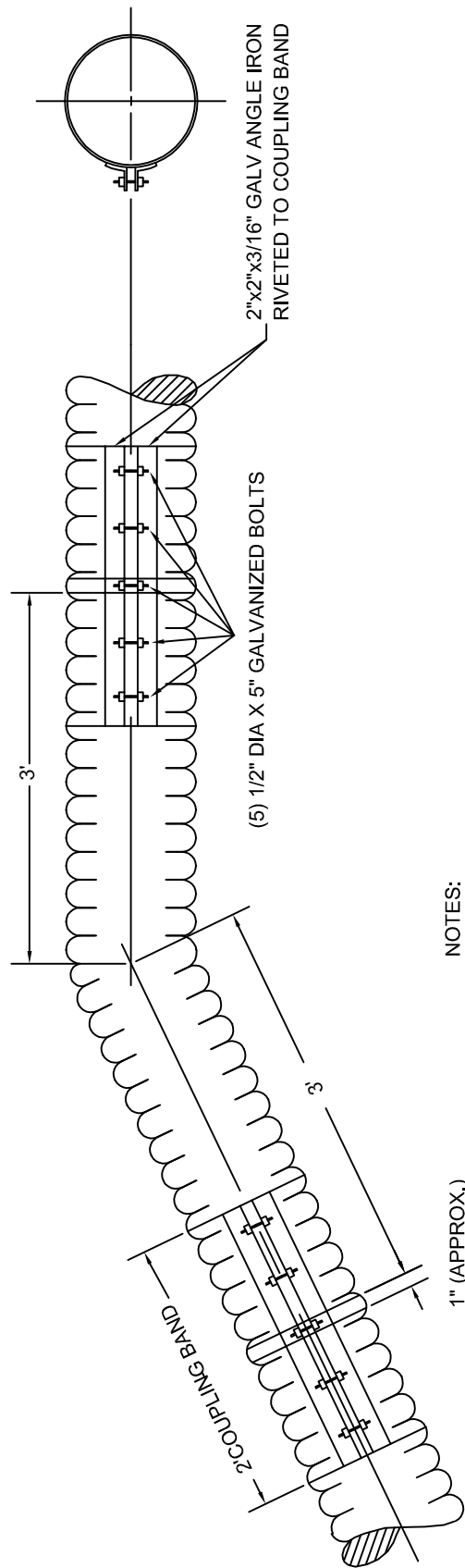
NOTES:

1. MINIMUM COVER IS TOP OF PIPE TO ROAD GRADE - 18"
2. FOR HEAVIER FILLS USE STRUCTURAL PLATE



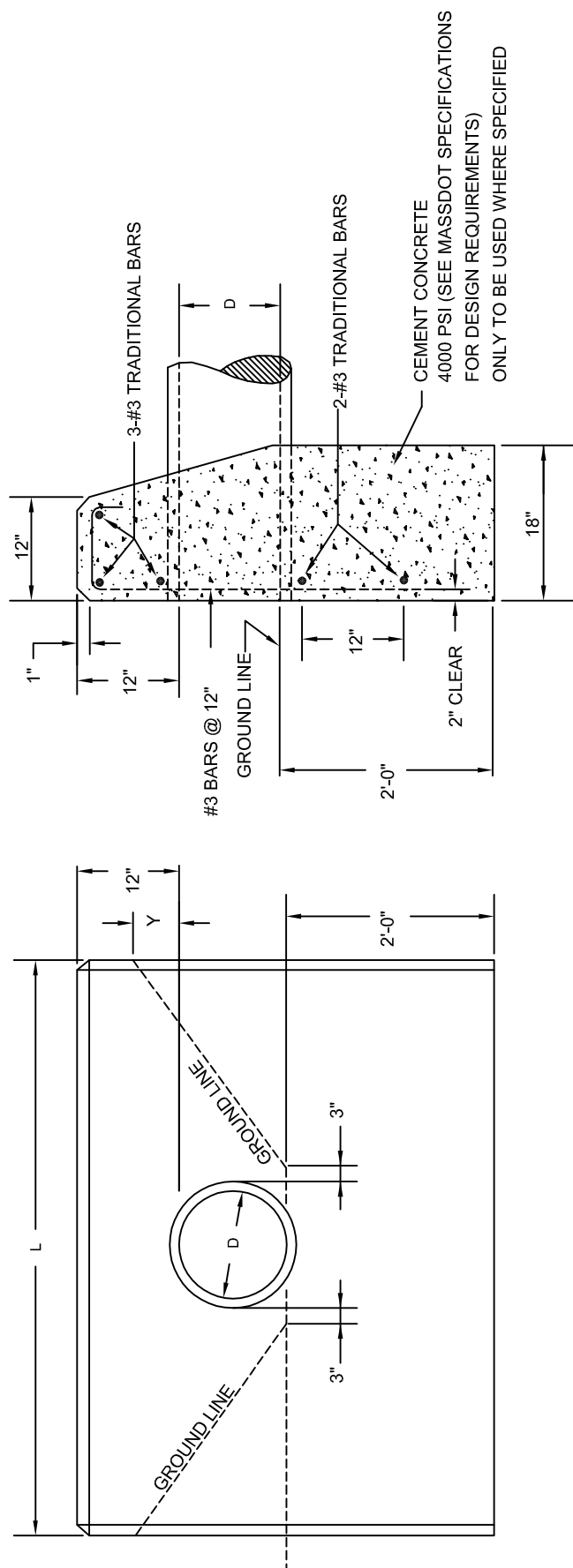


### ELBOW AND COUPLING DETAILS

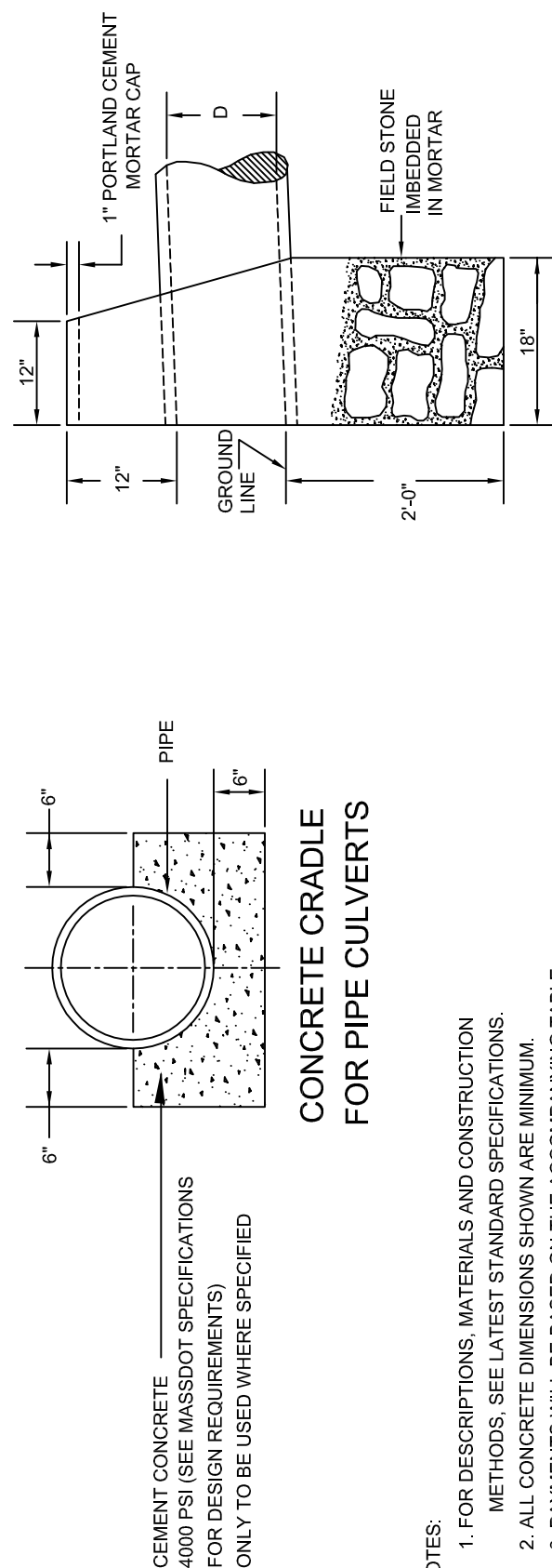


#### NOTES:

1. A TOE PLATE IS REQUIRED FOR ALL METAL ENDS.
2. ALL METAL END UNITS AND ELBOWS TO BE SHOP FABRICATED.



## FRONT ELEVATION

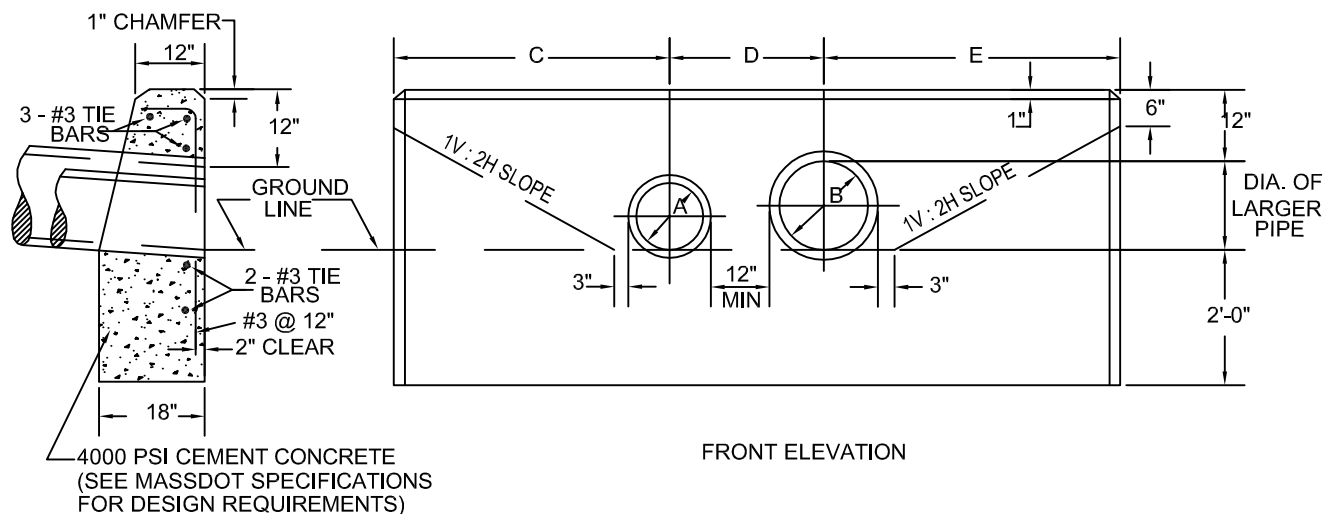


END ELEVATION

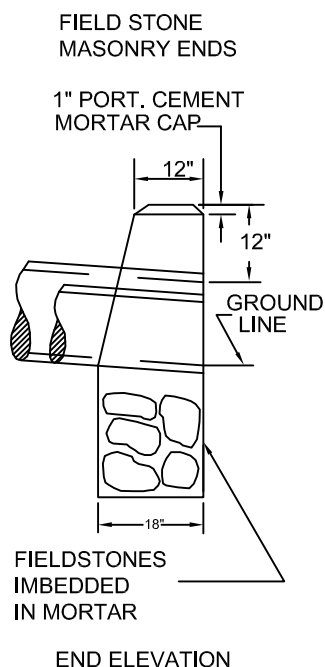
## NOTES:

1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENTS WILL BE BASED ON THE ACCOMPANYING TABLE.
4. FOR QUANTITY TABLES SEE E 206.4.1

ENGLISH UNITS									
PIPE DIAM. D	1 1/2 : 1 SLOPE					2 : 1 SLOPE			
	L	CONC. OR F.S.M. CU. YDS.	STEEL LBS.	TRENCH EXCAV. 1'-0" DEPTH CU. FT.	L	CONC. OR F.S.M. CU. YDS.	STEEL LBS.	TRENCH EXCAV. 1'-0" DEPTH CU. FT.	
8"	4'-2"	0.77	15	21.60	5'-10"	1.08	21	27.40	
10"	4'-10"	0.92	20	23.91	6'-8"	1.28	23	30.35	
12"	5'-6"	1.08	21	26.25	7'-6"	1.49	29	33.25	
15"	6'-6"	1.34	24	29.75	8'-9"	1.82	32	37.63	
18"	7'-6"	1.61	30	33.25	10'-0"	2.18	39	42.00	
21"	8'-6"	1.95	34	37.35	11'-6"	2.62	43	47.25	
24"	9'-3"	2.16	35	39.38	12'-6"	2.97	50	50.75	
30"	10'-6"	2.63	44	43.75	15'-0"	3.86	62	59.50	
Y					4" FOR 1 1/2 : 1 SLOPE				
					6" FOR 2 : 1 SLOPE				



END ELEVATION



DESIGN NO.	DIAMETER (IN.)		LENGTHS			MASONRY (CY)	STEEL (LBS)	TRENCH EXCAV. 1'-0" DEPTH (CF)
	A	B	C	D	E			
1	12	12	3'-9"	2'-2"	3'-9"	1.89	37	40.85
2	12	15	4'-3"	2'-4"	4'-5"	2.27	42	45.50
3	12	18	4'-9"	2'-6"	5'-0"	2.66	48	49.88
4	12	21	5'-4"	2'-8"	5'-8"	3.12	54	54.85
5	12	24	5'-9"	2'-10"	6'-3"	3.54	59	58.91
6	12	30	6'-9"	3'-0"	7'-6"	4.48	71	67.38
7	15	15	4'-5"	2'-6"	4'-5"	2.32	41	46.66
8	15	18	4'-11"	2'-8"	5'-0"	2.72	48	51.03
9	15	21	5'-5"	2'-10"	5'-8"	3.16	54	55.72
10	15	24	5'-11"	3'-0"	6'-3"	3.60	60	60.10
11	15	30	6'-11"	3'-2"	7'-6"	4.54	72	68.53
12	18	18	5'-0"	2'-8"	5'-0"	2.72	48	51.35
13	18	21	5'-7"	2'-10"	5'-8"	3.17	52	56.28
14	18	24	6'-0"	3'-0"	6'-3"	3.58	60	60.38
15	18	30	7'-0"	3'-2"	7'-6"	4.53	72	68.85
16	21	21	5'-8"	3'-0"	5'-8"	3.20	53	57.19
17	21	24	6'-2"	3'-4"	6'-3"	3.69	61	62.13
18	21	30	7'-2"	3'-6"	7'-6"	4.65	73	70.60
19	24	24	6'-3"	3'-4"	6'-3"	3.67	61	62.40
20	24	30	7'-3"	3'-8"	7'-6"	4.69	74	64.47
21	30	30	7'-6"	4'-0"	7'-6"	4.76	75	73.50

NOTE:

1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENTS WILL BE BASED ON THE QUANTITIES SHOWN IN ACCOMPANYING TABLE.



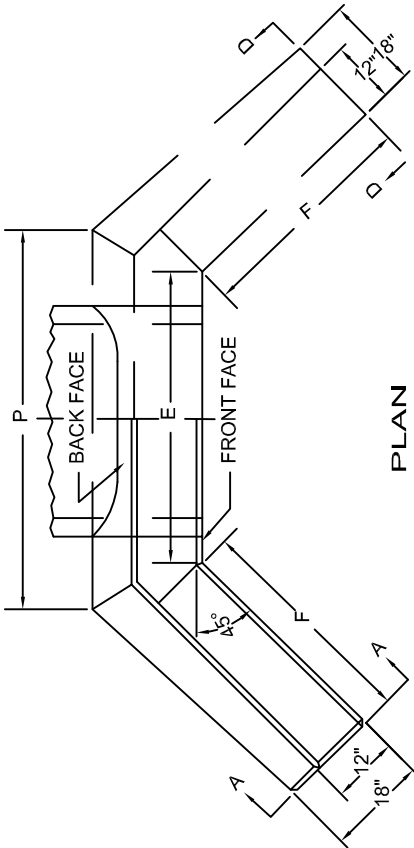
# CONCRETE AND FIELDSTONE MASONRY PIPE ENDS FOR 30" TO 84" PIPE

DATE OF ISSUE	OCTOBER 2017
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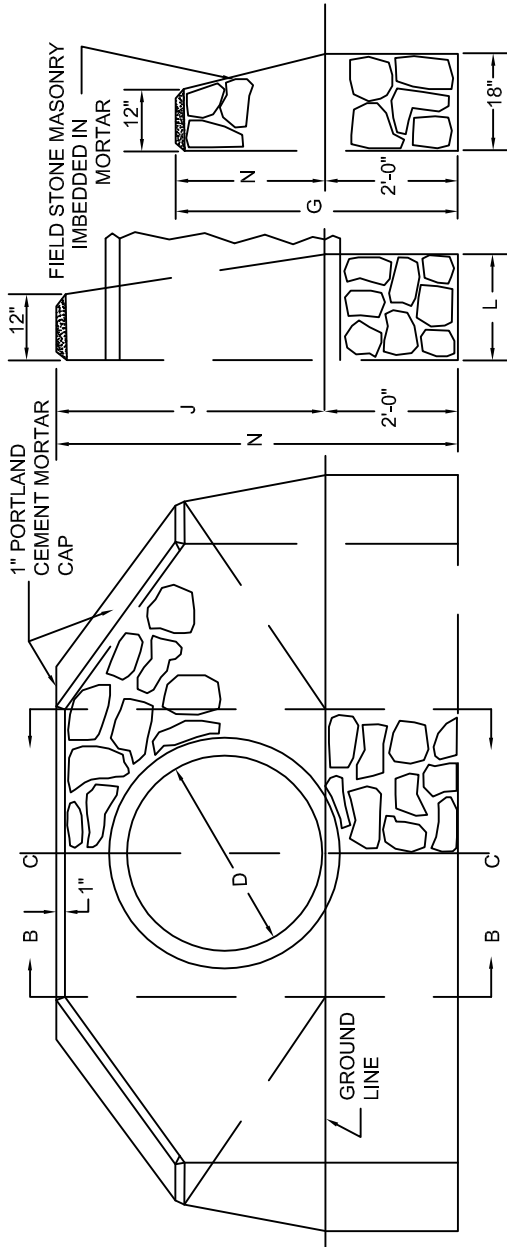
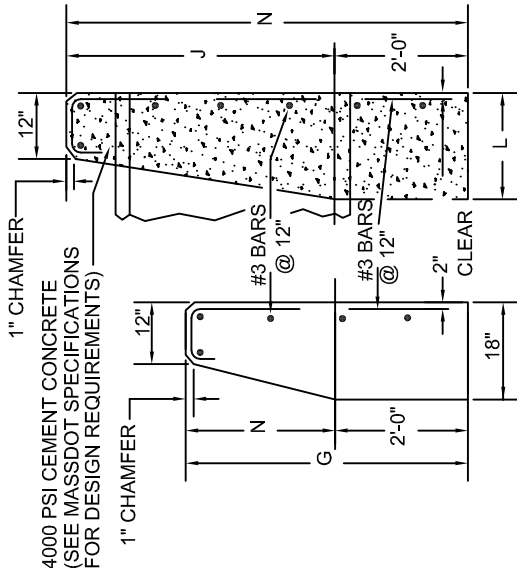
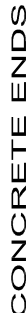
DRAWING NUMBER  
**E 206.6.0**

**NOTE:**

1. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE STANDARD SPECIFICATIONS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENTS WILL BE BASED ON THE QUANTITIES SHOWN IN THE ACCOMPANYING TABLE.



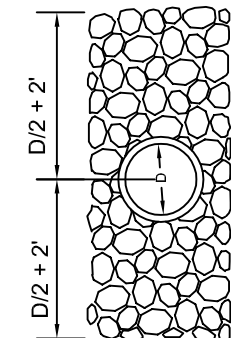
1V:1.5H AND 1V:2H SLOPES								1V:1.5H SLOPE		1V:2H SLOPE		TRENCH EXCAV. FOR 12 SLOPE FOR 1'40" DEPTH. CU. FT.
DE	EG	H	J	L	N	P	CONC. MASONRY	STEEL	F	CONC. MASONRY	STEEL	
							CY	LBS		CY	LBS	
30"	4'-0"	4'-0"	5'-6"	3'-6"	1'-6"	2'-0"	3'-0"	4'-3"	4'-3"	3.16	54	55.16
36"	4'-6"	4'-3"	6'-0"	4'-0"	1'-8"	2'-3"	3'-6"	3.35	5'-0"	4.15	64	64.36
42"	5'-0"	4'-6"	6'-6"	4'-6"	1'-10"	2'-6"	4'-0"	4.20	5'-9"	5.25	70	73.70
48"	5'-6"	4'-9"	7'-0"	5'-0"	2'-0"	2'-9"	4'-6"	5.19	6'-5"	6.50	83	83.96
54"	6'-0"	5'-0"	7'-6"	5'-6"	2'-2"	3'-0"	7'-10"	6.26	7'-3"	7.88	93	94.46
60"	6'-6"	5'-3"	8'-0"	6'-0"	2'-4"	3'-3"	8'-5"	7.43	8'-0"	9.37	106	105.30
72"	7'-6"	5'-9"	9'-0"	7'-0"	2'-8"	3'-9"	9'-9"	10.25	9'-6"	12.99	128	128.92
84"	8'-6"	6'-3"	10'-0"	8'-0"	3'-0"	4'-3"	11'-0"	13.49	120	17.32	154	153.86



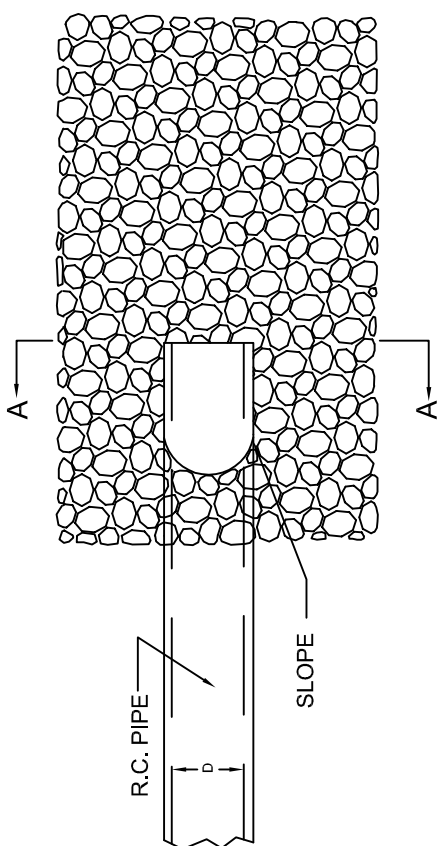
ELEV. A-A SECTION B-B

## FRONT ELEVATION

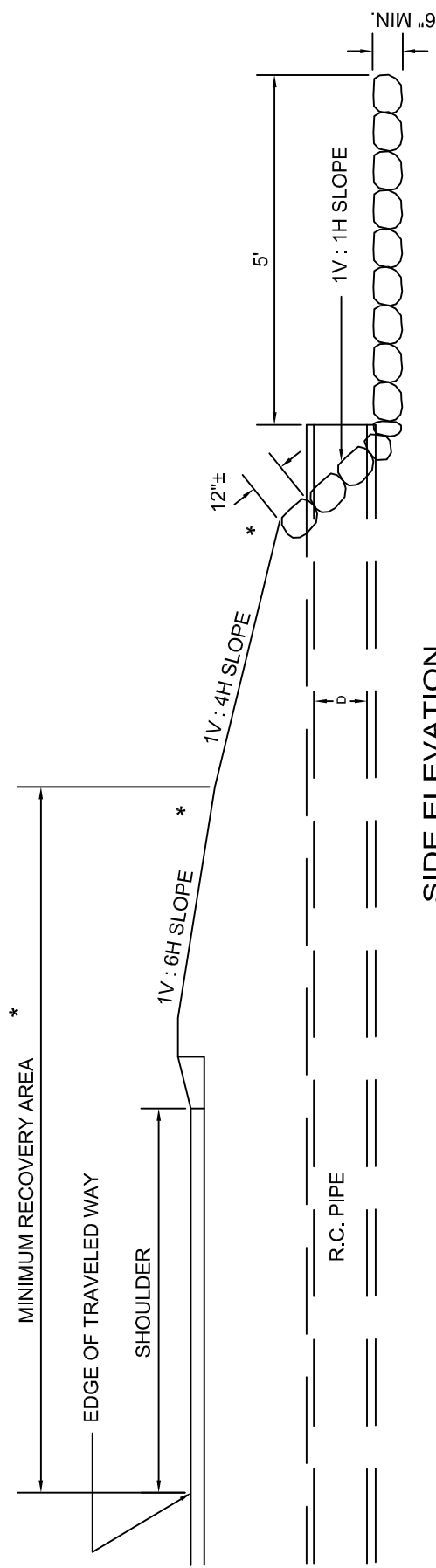
SECTION C-C ELEV. D-D



SECTION A-A



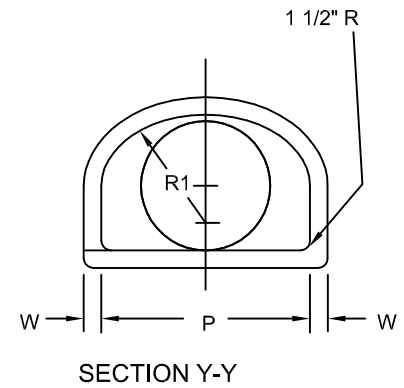
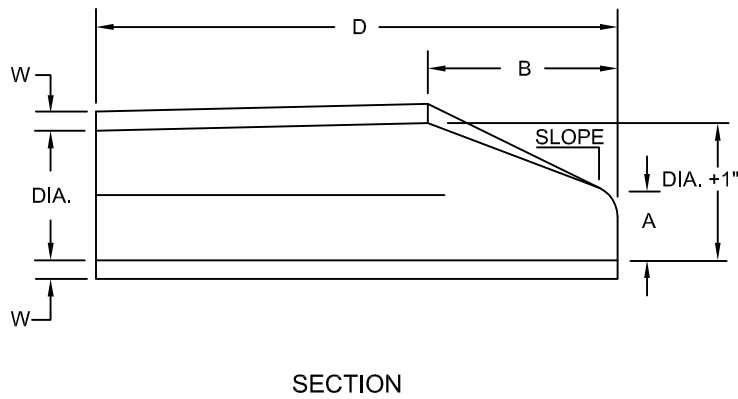
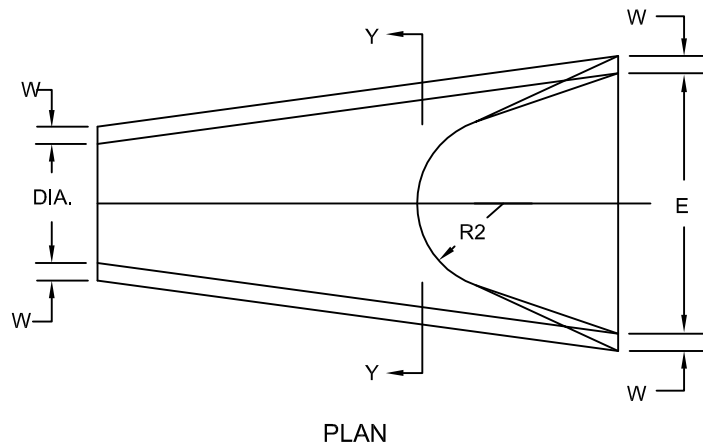
PLAN



SIDE ELEVATION

\* SEE TYPICAL SECTIONS.

- NOTES:
1. STONE TREATMENT OF PIPE ENDS SHALL NOT BE USED IN THE VEHICLE RECOVERY AREA.
  2. MINIMUM MASS PER STONE = 50 LBS; MAXIMUM MASS PER STONE = 125 LBS.
  3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.



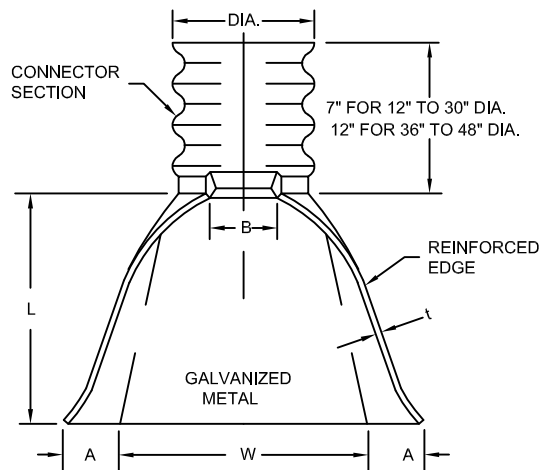
TABLE

[ALL DIMENSIONS ARE inches OR feet]

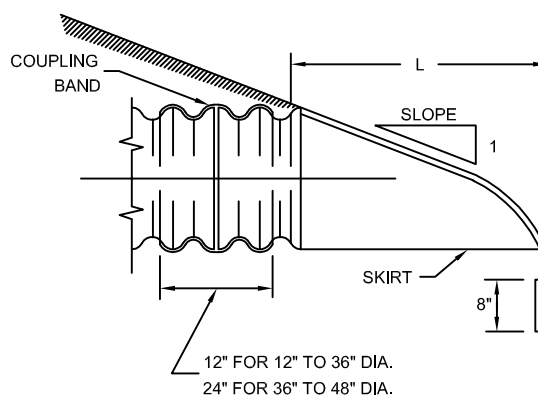
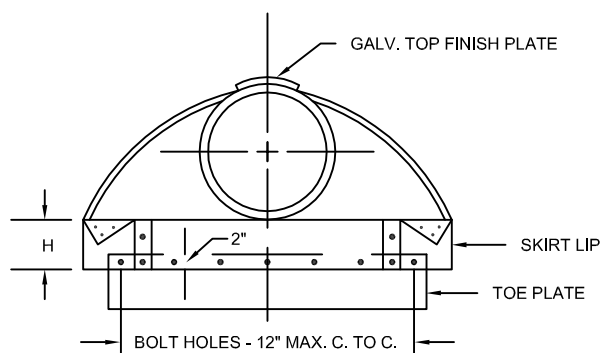
DIAMETER Inch	W	A	B	D	E	P	DIA. +1"	R1	R2	SLOPE
12"	2"	4"	2'-0"	6'-0"	2'-0"	19 15/16"	13"	10 1/8"	9"	1V : 3H
15"	2 1/4"	6"	2'-3"	6'-0"	2'-6"	24 5/16"	16"	12 1/2"	11"	1V : 3H
18"	2 1/2"	9"	2'-3"	6'-0"	3'-0"	29"	19"	15 1/2"	12"	1V : 3H
21"	2 3/4"	9"	2'-11"	6'-0"	3'-6"	31 5/8"	22"	16 1/8"	13"	1V : 3H
24"	3"	9 1/2"	3'-7 1/2"	6'-0"	4'-0"	33 3/16"	25"	16 13/16"	14"	1V : 3H
27"	3 1/4"	10 1/2"	4'-0"	6'-0"	4'-6"	36"	28"	18 9/16"	14 1/2"	1V : 3H
30"	3 1/2"	12"	4'-6"	6'-0"	5'-0"	37"	31"	18 1/2"	15"	1V : 3H
36"	4"	15"	5'-3"	8'-0"	6'-0"	47 13/16"	37"	24 5/16"	20"	1V : 3H
42"	4 1/2"	21"	5'-3"	8'-0"	6'-6"	53 7/8"	43"	27 1/2"	22"	1V : 3H
48"	5"	24"	6'-0"	8'-0"	7'-0"	56 1/2"	49"	28 1/2"	22"	1V : 3H

NOTES:

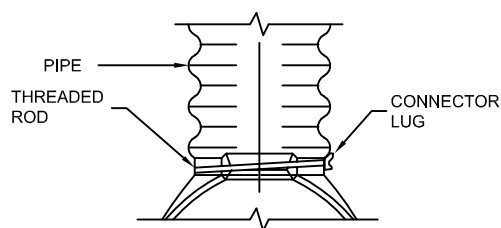
1. SEE STANDARD SPECIFICATIONS FOR THE TYPE OF PIPE TO BE USED (BELL & SPIGOT OR TONGUE & GROOVE)
2. SEE STANDARD SPECIFICATIONS FOR THE TYPE OF PIPE AND PLACING OF STEEL REINFORCEMENT.
3. THE JOINTS ARE TO BE COMPATIBLE WITH THE MAIN RUN OF PIPE.



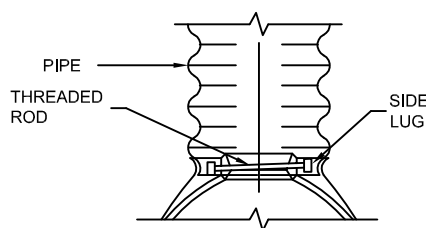
PIPE DIA. (IN)	GA.	DIMENSIONS (IN.)					APPROX. SLOPE
		A ( $\pm 1"$ )	B (MAX.)	H ( $\pm 1"$ )	L ( $\pm 1\ 1/2"$ )	W ( $\pm 2"$ )	
12	16	6	6	6	21	24	1V : 2.5H
15	16	7	8	6	26	30	1V : 2.5H
18	16	8	10	6	31	36	1V : 2.5H
21	16	9	12	6	36	42	1V : 2.5H
24	16	10	13	6	41	48	1V : 2.5H
30	14	12	16	8	51	60	1V : 2.5H
36	14	14	19	9	60	72	1V : 2.5H
42	12	16	22	11	39	84	1V : 2.5H
48	12	18	27	12	78	90	1V : 2.25H



### ALTERNATE CONNECTIONS



FOR 12" TO 24" ONLY



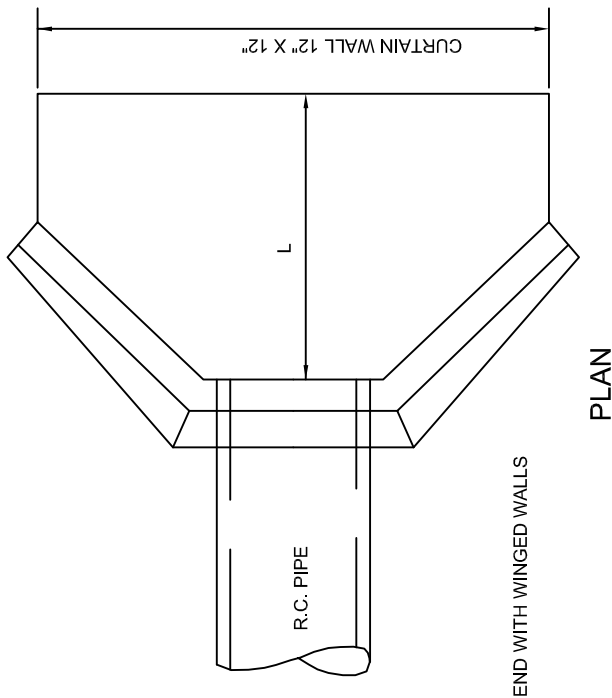
FOR 30" AND 36" ONLY

#### NOTES:

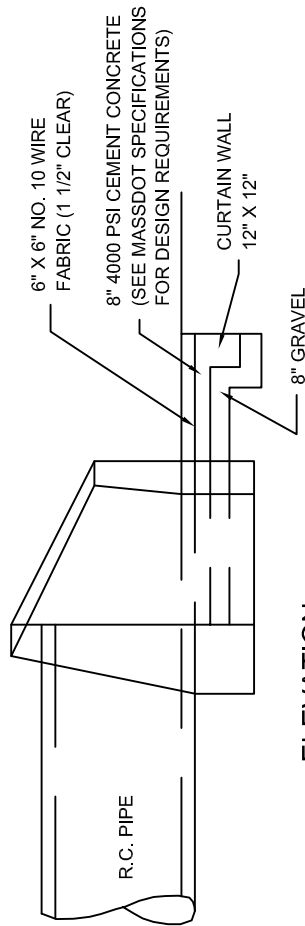
1. TOE PLATE TO BE PUNCHED TO MATCH HOLES IN SKIRT LIP. 3/8"  $\varnothing$  GALVANIZED BOLTS TO BE FURNISHED. LENGTH OF TOE PLATE TO BE W+10" FOR 12" TO 30" DIA. PIPE AND W+22" FOR 36" TO 48" DIA.
2. SKIRT SECTION FOR 12" TO 24" DIA. PIPE TO BE MADE IN ONE PIECE. SKIRT SECTION FOR 12" TO 30" DIA. PIPE MAY BE MADE FROM TWO SHEETS JOINED BY RIVETING OR BOLTING ON CENTER LINE WITH 3/8" DIA. FASTENERS.
3. CONNECTOR SECTION, TOE PLATE AND SKIRT TO BE OF SAME THICKNESS METAL; EACH TO BE GALVANIZED AND COATED WITH A TAR BASE PAINT.
4. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE LATEST STANDARD SPECIFICATIONS.



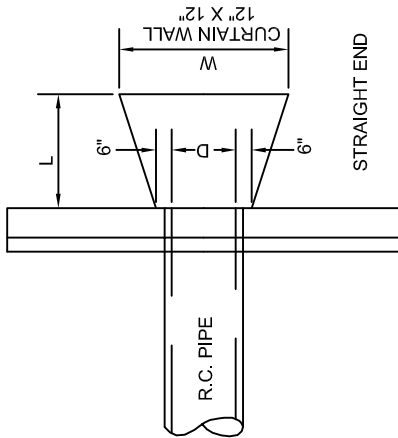
# CONCRETE SPLASH PADS



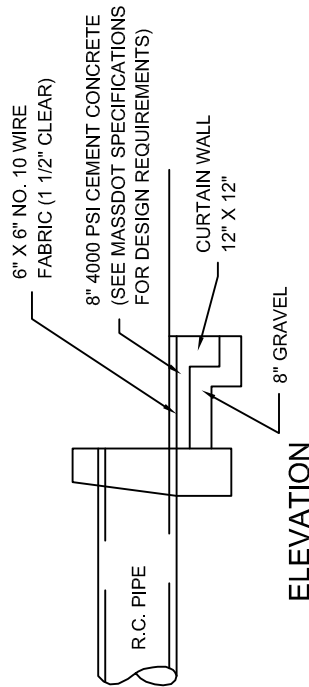
PLAN



ELEVATION



PLAN



ELEVATION

PIPE DIAM. (IN)	36	42	48	54	60	66	72	84
L (FT)	6	7	8	9	10	11	12	14

PIPE DIAM. (IN)	12	15	18	21	24	30
L	3'-0"	3'-0"	3'-0"	3'-6"	4'-0"	5'-0"
W	4'-0"	4'-0"	4'-6"	5'-3"	6'-0"	7'-6"

NOTE:  
1) ALL PIPE DIAMETERS NOMINAL SIZE

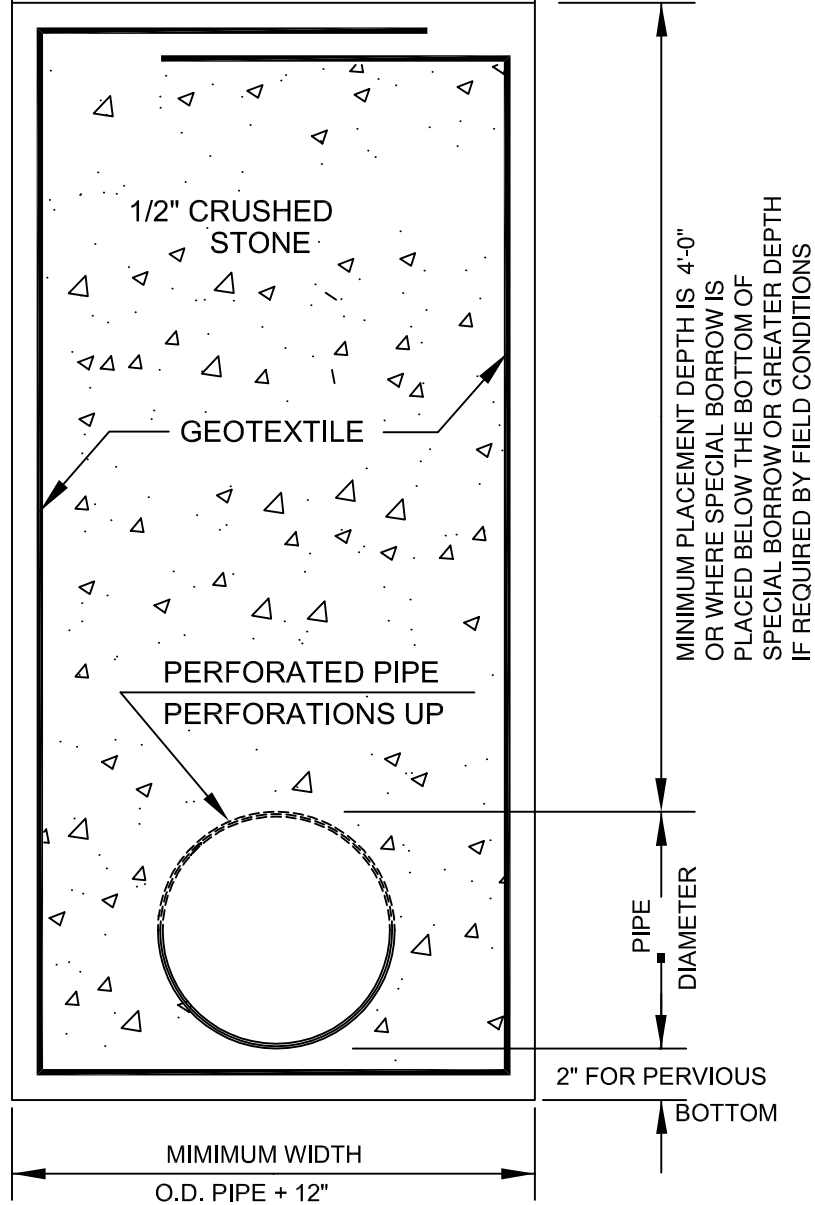


SURFACE TREATMENT:

4" PLANTABLE SOIL AND SEED  
OVER

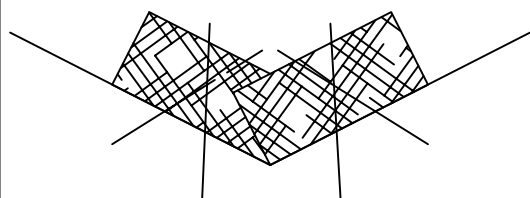
8" COMPACT GRAVEL OR

4" MINIMUM DEPTH OF PAVEMENT  
MILLING MULCH PLACE DIRECTLY  
OVER GEOTEXTILE AND CRUSHED  
STONE BOX



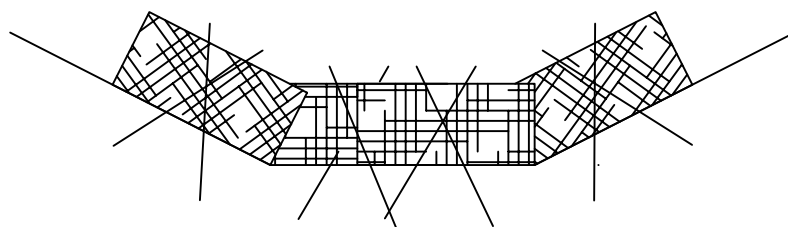
NOTES:

1. GEOTEXTILE FABRIC AS DESCRIBED IN SECTION M9.50
2. PIPE SHALL BE SET AT BOTTOM OF TRENCH FOR IMPERVIOUS BOTTOM.
3. SUBDRAIN LOCATED APPROXIMATELY AT INTERSECTION OF TANGENTS (SEE DWG. E102.1.0)
4. GRAVEL (AND SPECIAL BORROW WHERE REQUIRED) SHALL INTERSECT CRUSHED STONE FOR SUBDRAIN



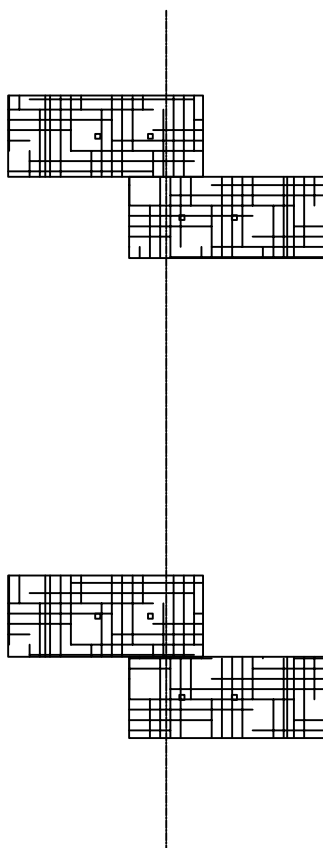
V DITCH

CROSS SECTION



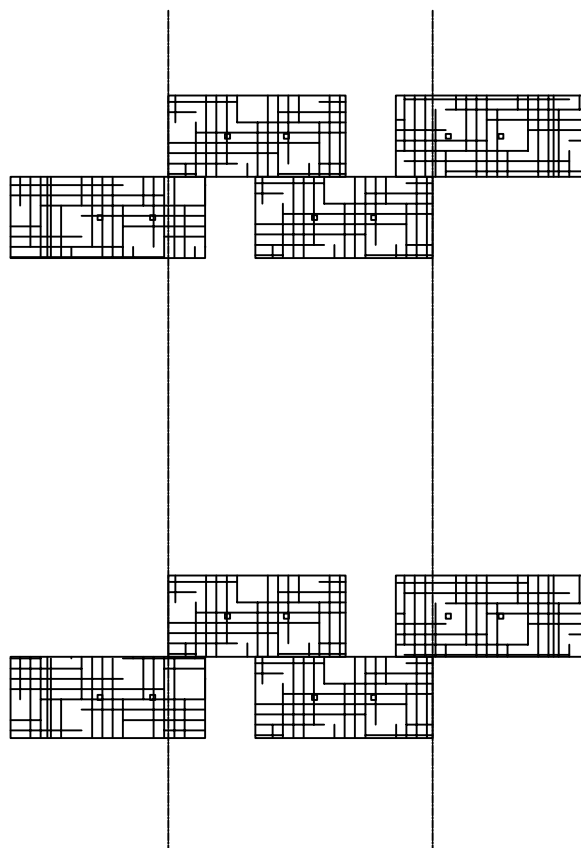
FLAT DITCH

CROSS SECTION



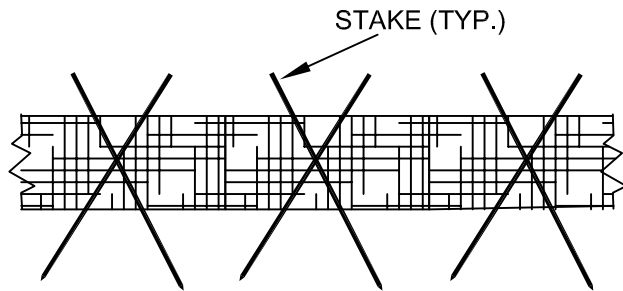
V DITCH

PLAN

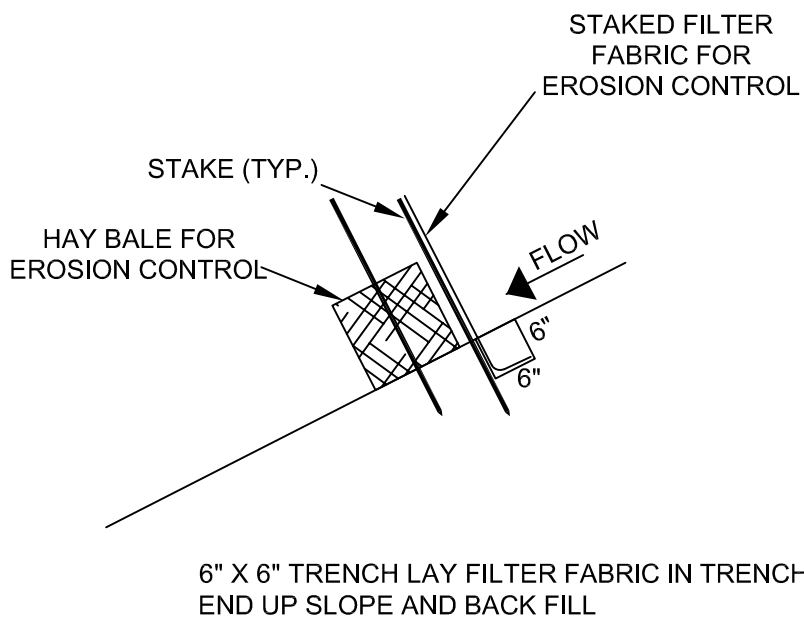
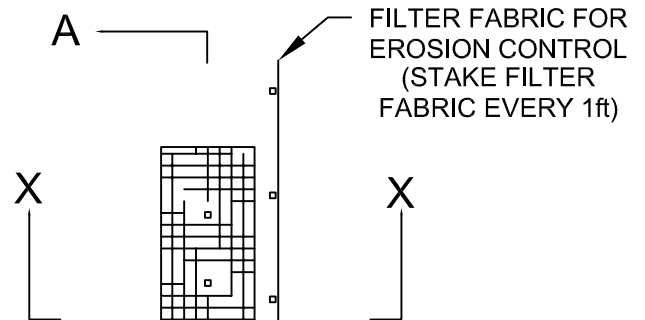


FLAT DITCH

PLAN



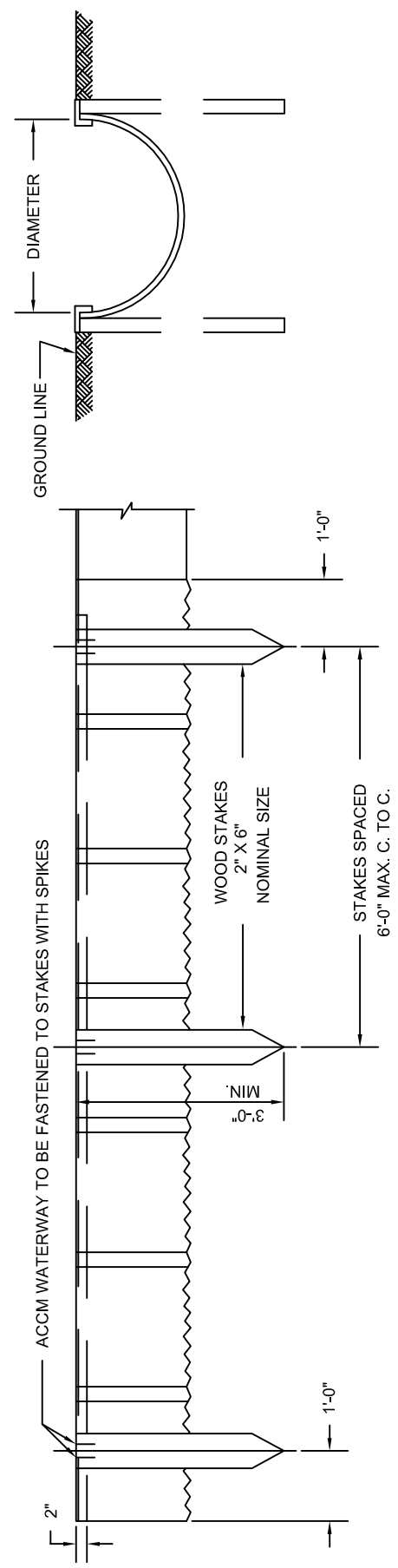
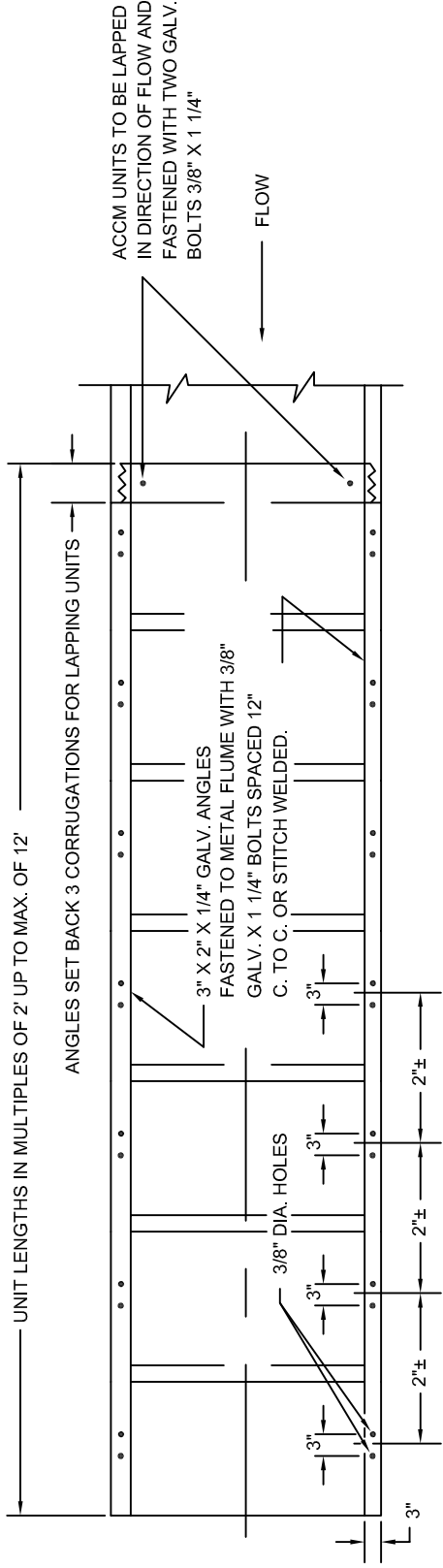
SECTION A-A



SECTION X-X

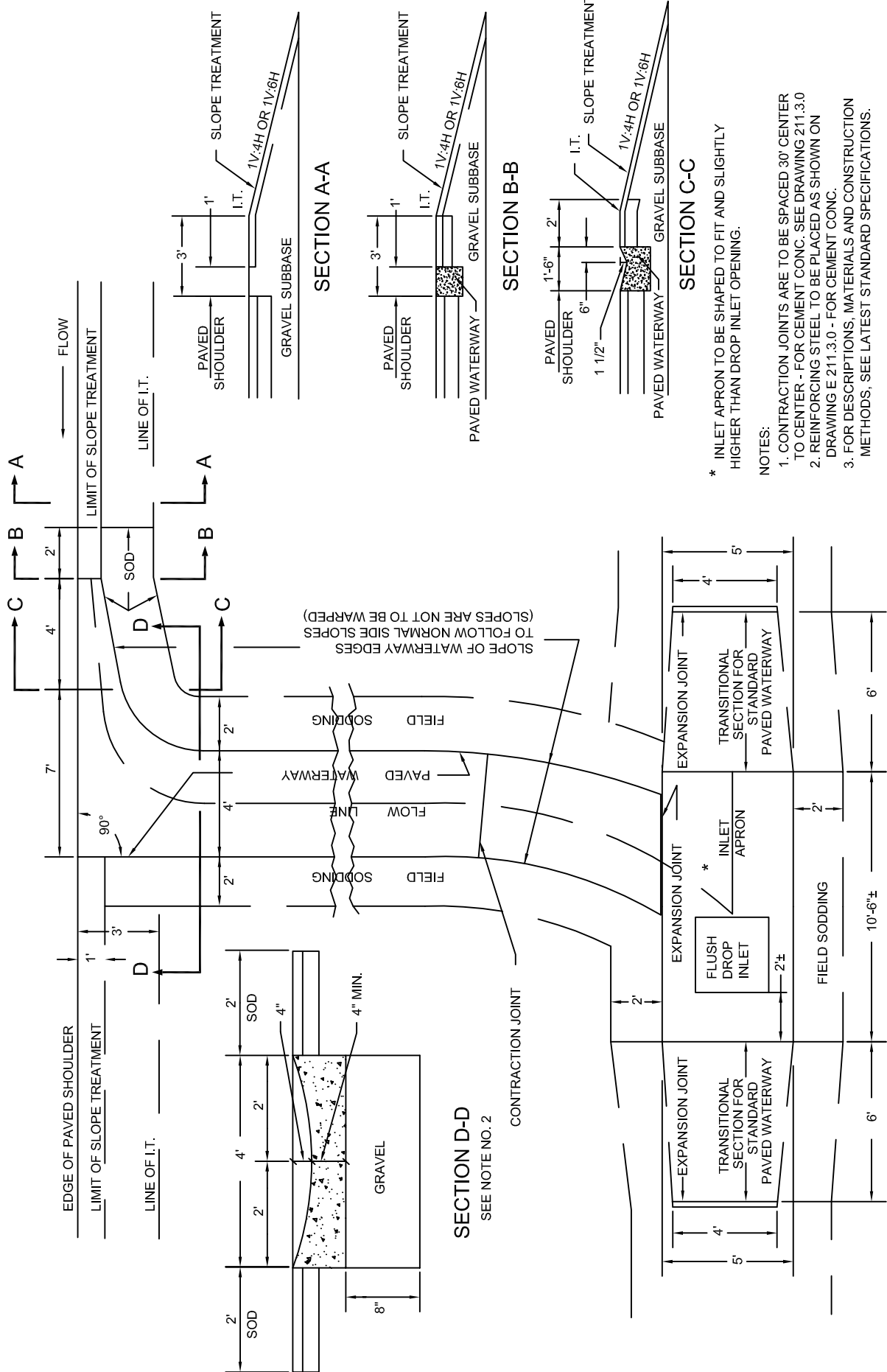
HAY BALES FOR  
EROSION CONTROL  
(2 STAKES  
PER BALE)

A



NOTE:  
 1. DIAMETER OF HALF CCM PIPE WATERWAY TO BE AS SPECIFIED.  
 2. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.

# **HALF CIRCLE CCM PIPE WATERWAYS**



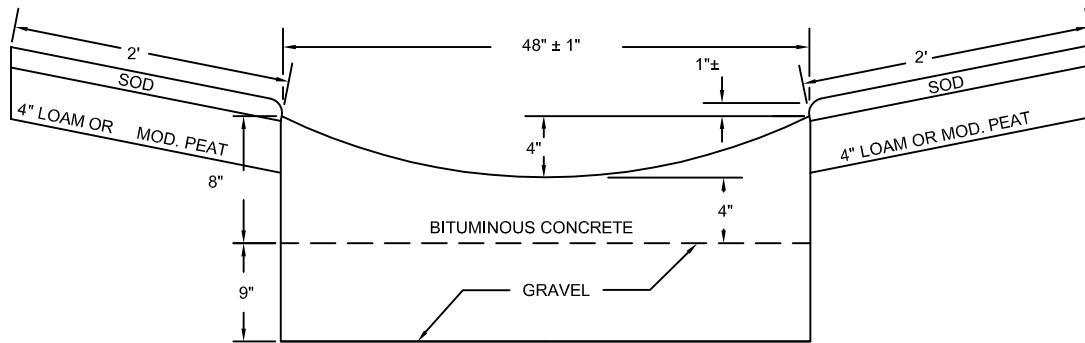
- \* INLET APRON TO BE SHAPED TO FIT AND SLIGHTLY HIGHER THAN DROP INLET OPENING.
- NOTES:
1. CONTRACTION JOINTS ARE TO BE SPACED 30' CENTER TO CENTER - FOR CEMENT CONC. SEE DRAWING 211.3.0
  2. REINFORCING STEEL TO BE PLACED AS SHOWN ON DRAWING E 211.3.0 - FOR CEMENT CONC.
  3. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.

SECTION D-D  
SEE NOTE NO. 2

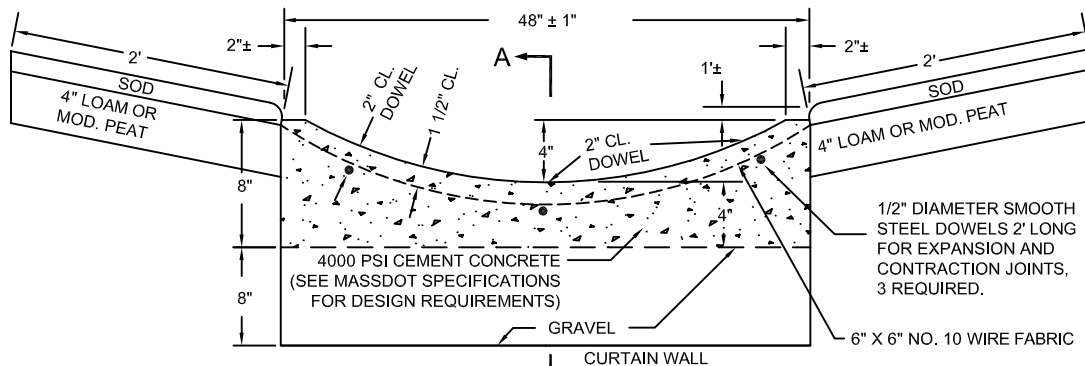
# PAVED WATERWAYS AND APRON

DATE OF ISSUE  
OCTOBER 2017

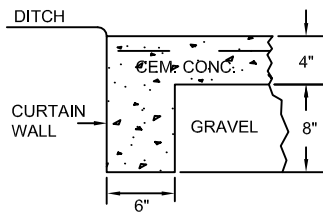
DRAWING NUMBER  
**E 211.2.0**



BITUMINOUS CONCRETE

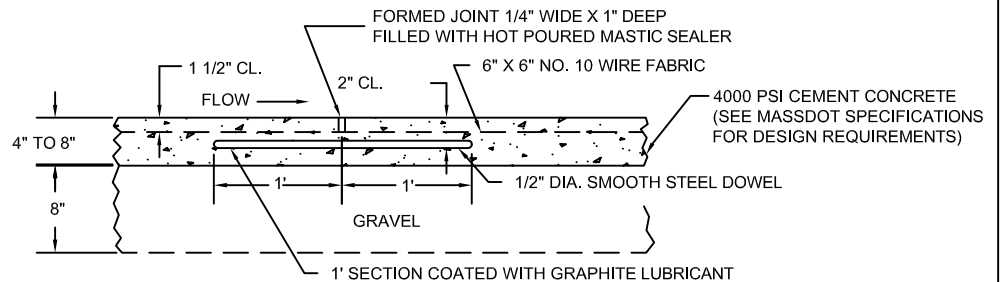


CEMENT CONCRETE



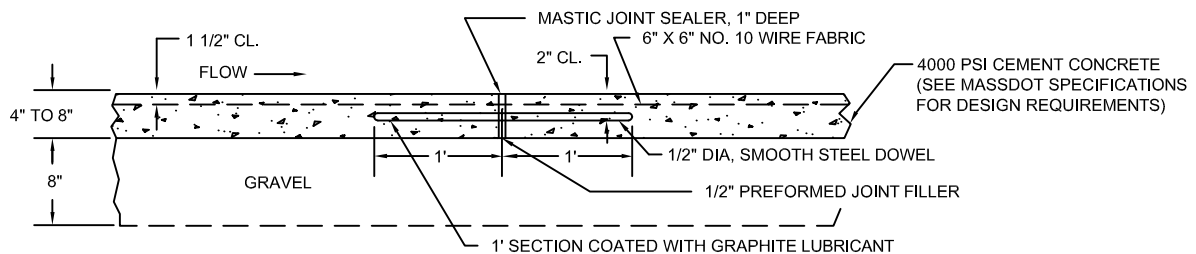
CURTAIN WALL TO BE INSTALLED  
AT TERMINI OF PAVING

SECTION A-A



CONTRACTION JOINT TO BE PLACED 30' MAXIMUM CENTER TO CENTER

DETAILS OF CONTRACTION JOINTS



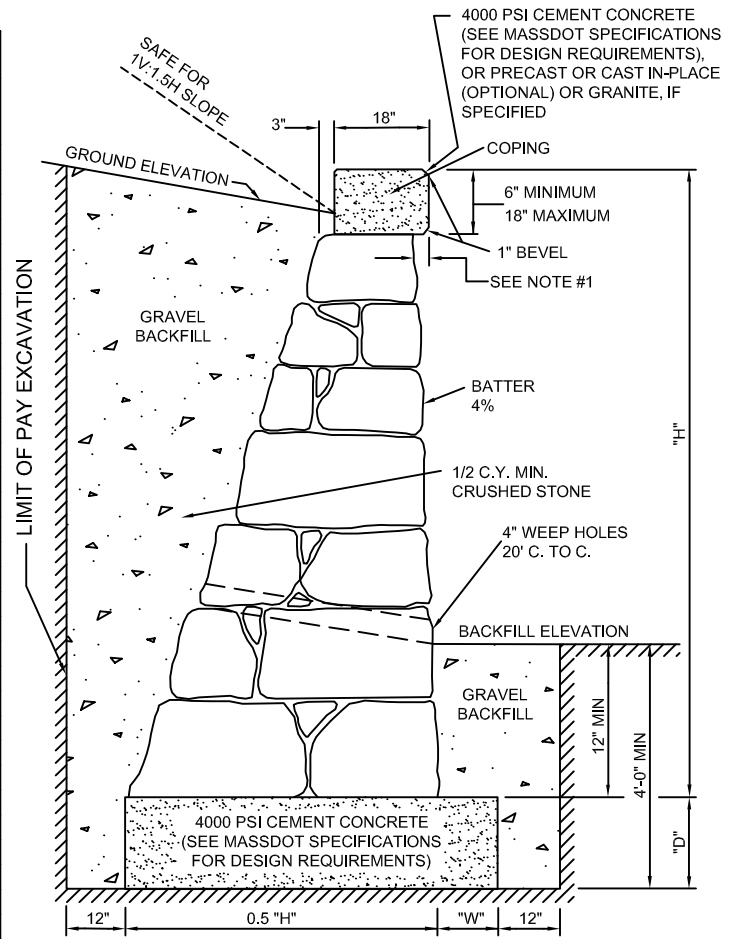
EXPANSION JOINTS TO BE INSTALLED AT APPROACHES TO STRUCTURES

DETAILS OF EXPANSION JOINTS

NOTES:

1. ON CURVED ALIGNMENT, WATERWAYS SHALL BE BANKED AS DIRECTED.
2. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.

H (FT)	W (FT)	D (FT)	CONCRETE MASONRY FOOTING		STONE MASONRY EXCLUDING COPING	
			SECTION AREA (SQ. FT.)	VOLUME PER UNIT LENGTH (CU. YD./LIN. FT.)	SECTION AREA (SQ. FT.)	VOLUME PER UNIT LENGTH (CU. YD./LIN. FT.)
5.0	0.75	1.25	4.06	0.150	9.00	0.333
5.5			4.38	0.162	10.63	0.394
6.0			4.69	0.174	12.38	0.458
6.5			5.00	0.185	14.16	0.524
7.0			5.31	0.197	16.05	0.594
7.5			5.63	0.208	18.06	0.669
8.0	1.0	1.5	7.50	0.278	20.16	0.747
8.5			7.88	0.292	22.40	0.829
9.0			8.25	0.306	24.75	0.917
9.5			8.63	0.319	27.22	1.008
10.0	1.2	2.0	12.40	0.459	29.80	1.104
10.5			12.90	0.478	32.50	1.204
11.0			13.40	0.496	35.28	1.307
11.5			13.90	0.515	38.21	1.415
12.0			14.40	0.533	41.25	1.528
12.5			14.90	0.552	44.41	1.645
13.0	1.5	2.5	20.00	0.741	47.68	1.766
13.5			20.63	0.764	51.07	1.891
14.0			21.25	0.787	54.53	2.020
14.5			21.88	0.810	58.14	2.153
15.0			22.50	0.833	61.88	2.292
15.5			23.13	0.856	65.72	2.434
16.0			23.75	0.880	69.68	2.581
16.5	1.8	3.0	30.15	1.117	73.76	2.732
17.0			30.90	1.144	77.90	2.885
17.5			31.65	1.172	82.21	3.045
18.0			32.40	1.200	86.63	3.208
18.5			33.15	1.228	91.38	3.384
19.0			33.90	1.256	96.25	3.565
19.5			34.65	1.283	101.25	3.750
20.0			35.40	1.311	106.38	3.940
20.5			36.15	1.339	111.63	4.134
21.0			36.90	1.367	117.00	4.333
21.5			37.65	1.394	122.50	4.537
22.0			38.40	1.422	128.13	4.745
22.5			39.15	1.450	133.88	4.958
23.0			39.90	1.478	139.75	5.176
23.5			40.65	1.506	145.75	5.398
24.0			41.40	1.533	151.88	5.625
24.5			42.15	1.561	158.13	5.856
25.0			42.90	1.589	164.50	6.093
25.5			43.65	1.617	171.00	6.333
26.0			44.40	1.644	177.63	6.579
26.5			45.15	1.672	184.38	6.829



COPING TO BE PRECAST CONCRETE OR GRANITE OF UNIFORM DEPTH FOR THE ENTIRE LENGTH. DEPTH OF CONCRETE TO BE 1/12 THE AVERAGE "H" WITHIN THE LIMITS SHOWN. DEPTH OF GRANITE TO BE AS SHOWN ON THE PLANS, 6" OR 9".

FOR CHAIN LINK FENCE ON TOP OF WALL, THE COPING SHALL BE CONCRETE CAST-IN-PLACE WITH A MINIMUM DEPTH OF 12". THE LENGTH OF GALVANIZED PIPE SLEEVES FOR FENCE POSTS SHALL BE EQUAL TO THE DEPTH OF COPING.

#### NOTES:

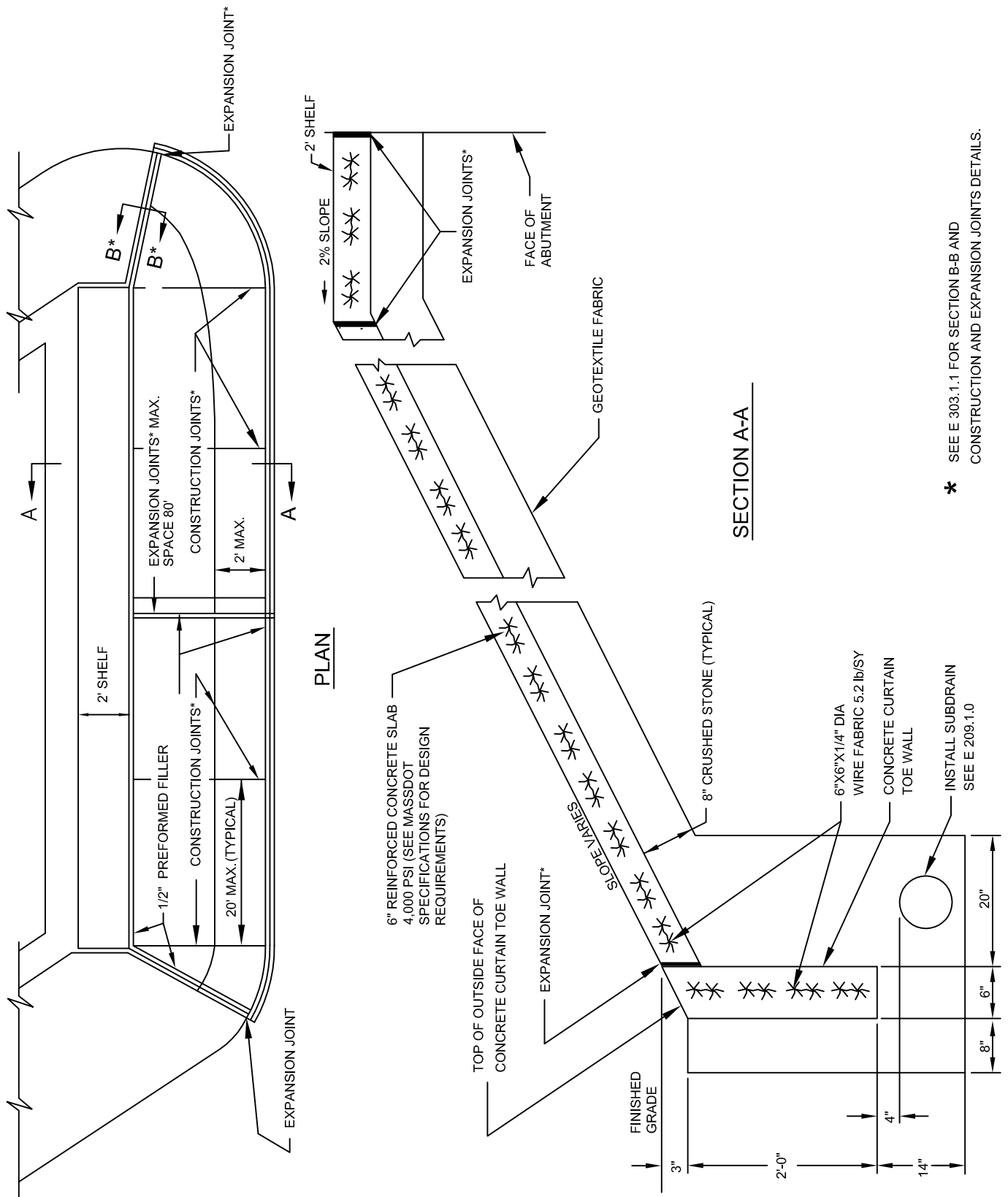
1. COPING OVERHANG TO BE APPROXIMATELY 3" FOR WALLS 10' OR MORE IN HEIGHT AND APPROXIMATELY 2" FOR WALLS LESS THAN 10' IN HEIGHT; IN A CONTINUOUS WALL OF VARYING HEIGHT THE OVERHANG WILL BE APPROXIMATELY 2" TO 3" FOR THE ENTIRE LENGTH.
2. ALL DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENT WILL BE BASED ON THE ACCOMPANYING TABLE.
4. TO BE FOUNDED ON SUITABLE SOIL.

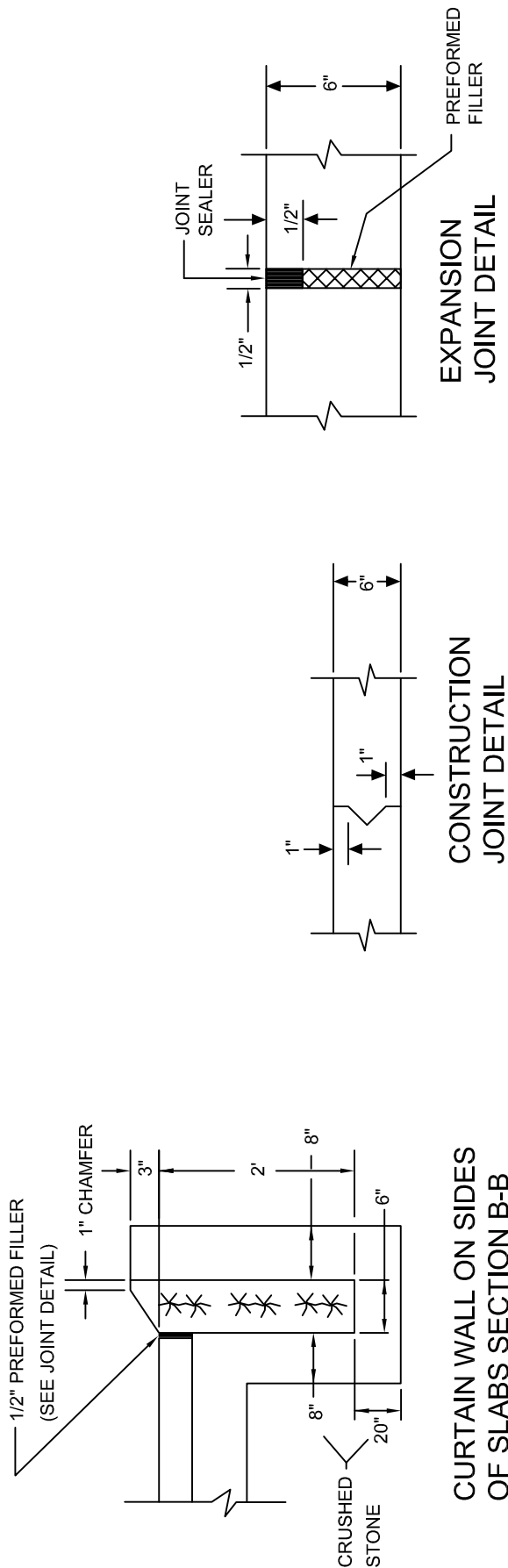


# **SPECIAL SLOPE PAVING UNDER BRIDGES REINFORCED CONCRETE SLAB**

DATE OF ISSUE  
OCTOBER 2017

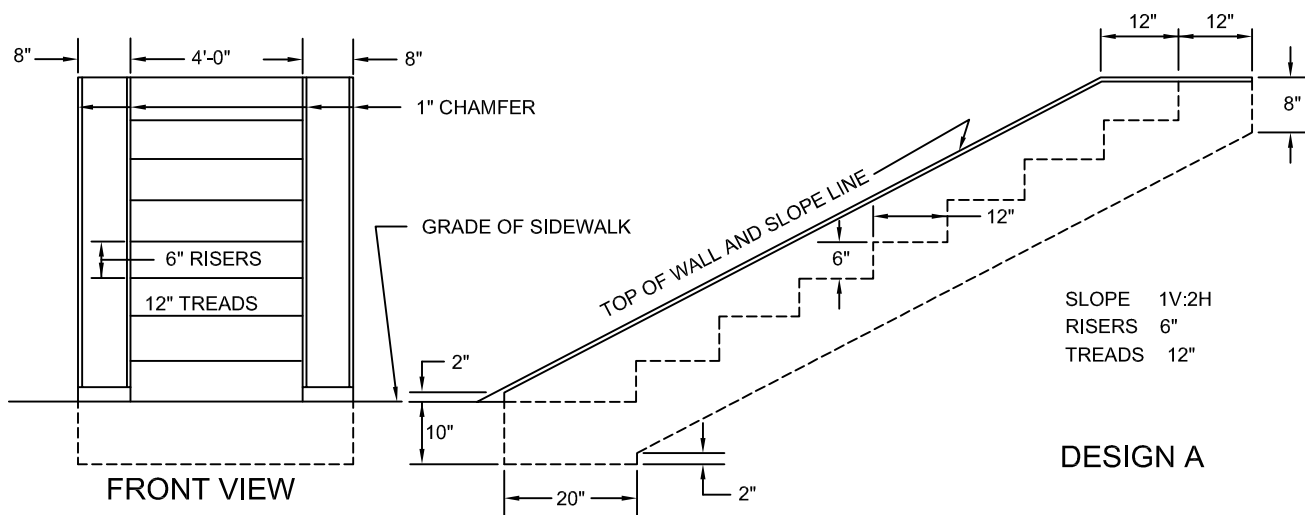
DRAWING NUMBER  
**E 303.1.0**



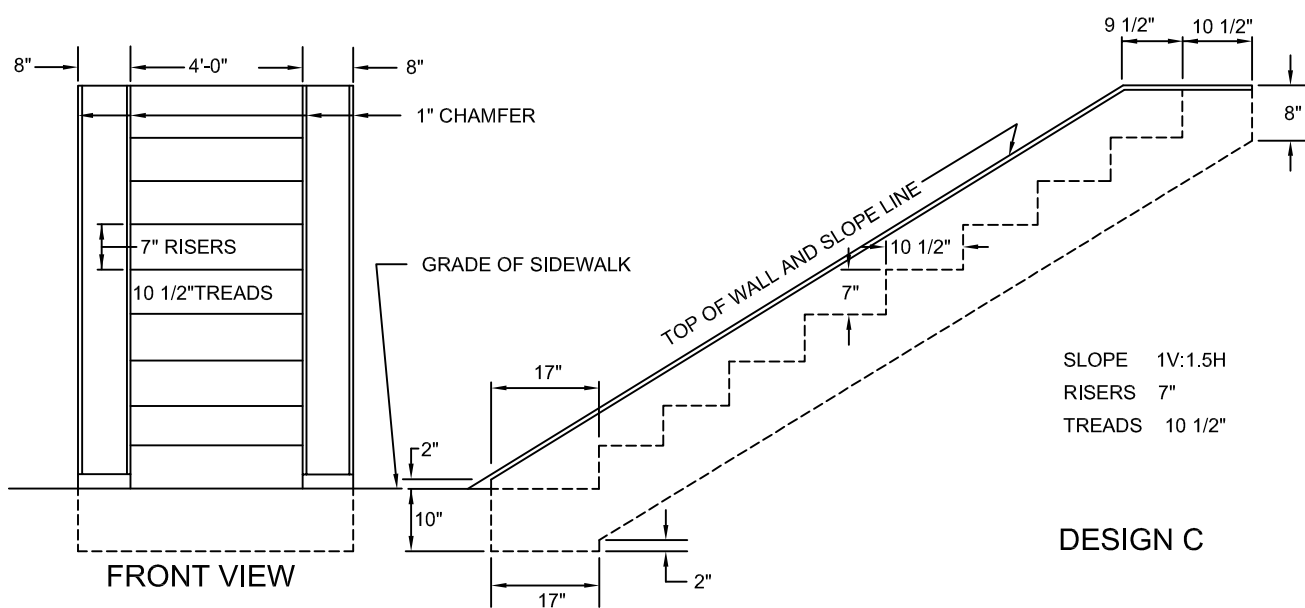


#### NOTES:

1. WIRE FABRIC TO HAVE 12" MINIMUM LAP AT SPLICE AND SHOULD EXTEND WITHIN 3" OF ALL EDGES
2. SLAB SHALL BE GROOVED PARALLEL TO AND NORMAL TO THE CURTAIN TOE WALL AT APPROXIMATELY 6' GRIDS. THE GROOVE DEPTH SHALL BE 1"
3. FOR LIMITS OF SLOPE PAVING SEE BRIDGE MANUAL.
4. CONCRETE SHALL BE 4,000 PSI (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
5. EXTEND GEOTEXTILE FABRIC BENEATH CRUSHED STONE FROM TOP OF CONCRETE CURTAIN TOE WALL TO FACE OF ABUTMENT.
6. SEE E 303.1.0 FOR SLAB PLAN AND SECTION.



PLEASE NOTE: DESIGN B HAS BEEN DISCONTINUED



NOTES:

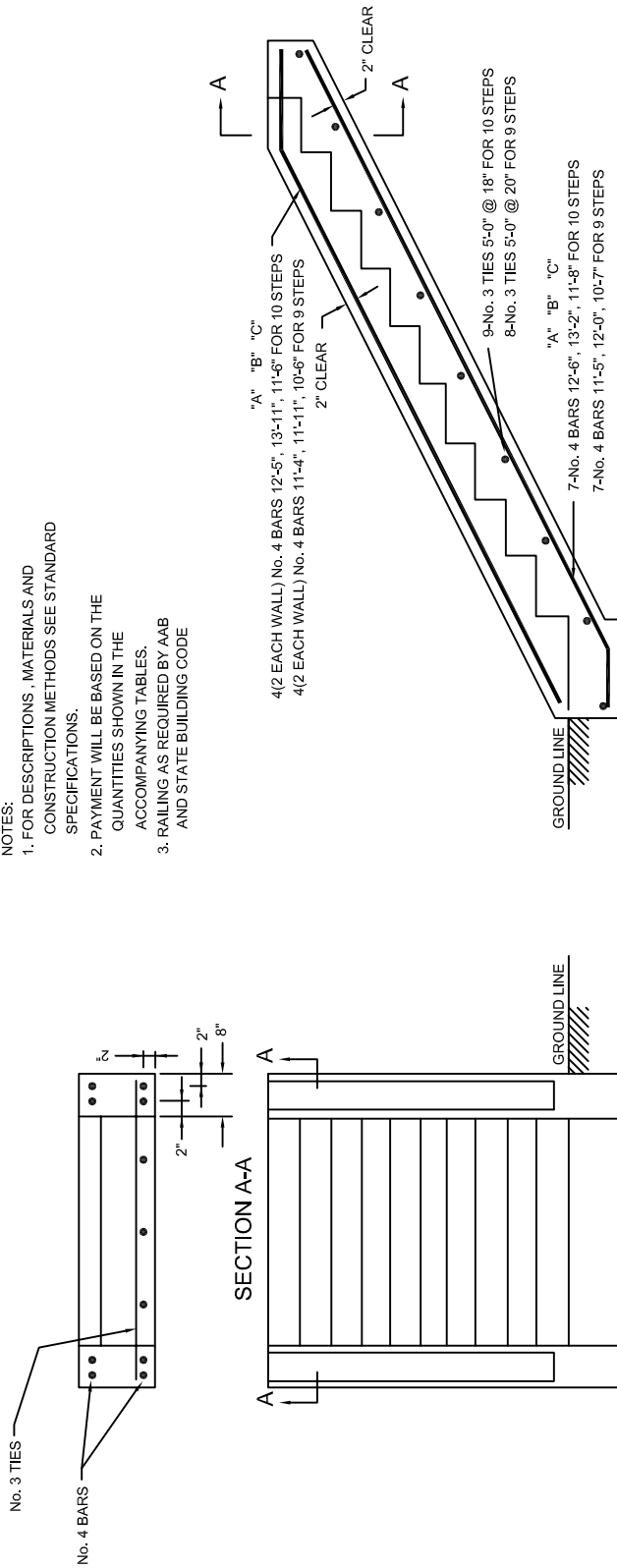
1. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM EXCEPT RISERS AND TREADS WHICH HAVE 1/4" TOLERANCE.
2. FOR REINFORCING STEEL AND CONCRETE QUANTITIES SEE DRAWING E 304.2.0

# CEMENT CONCRETE STEPS

## 2/2

**NOTES:**

1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS SEE STANDARD SPECIFICATIONS.
2. PAYMENT WILL BE BASED ON THE QUANTITIES SHOWN IN THE ACCOMPANYING TABLES.
3. RAILING AS REQUIRED BY AAB AND STATE BUILDING CODE



FRONT VIEW

SIDE VIEW

FOR DESIGNS "A", "B" AND "C" SEE DRAWING E 304.1.0

		DESIGN A					DESIGN C					
STEP NOS.	QUANTITIES - CU. FT.				TOTAL C.Y.	REINF. STEEL LBS	QUANTITIES - CU. FT.				TOTAL C.Y.	REINF. STEEL LBS
	BASE	STEPS	2-WALLS	TOTAL			BASE	STEPS	2-WALLS	TOTAL		
2	5.55	7.33	6.26	19.15	0.71	--	4.72	6.71	5.65	17.08	0.63	--
3	5.55	11.00	8.48	25.03	0.93	--	4.72	10.06	7.69	22.48	0.83	--
4	5.55	14.66	10.70	30.92	1.15	--	4.72	13.42	9.73	27.87	1.03	--
5	5.55	18.33	12.92	36.81	1.36	--	4.72	16.77	11.78	33.27	1.23	--
6	5.55	22.00	15.15	42.70	1.58	--	4.72	20.12	13.82	38.66	1.43	--
7	5.55	25.66	17.37	48.59	1.80	--	4.72	23.48	15.86	44.06	1.63	--
8	5.55	29.33	19.59	54.47	2.02	--	4.72	26.83	17.90	49.46	1.83	--
9	5.55	33.00	21.81	60.36	2.24	99	4.72	30.19	19.94	54.85	2.03	92
10	5.55	36.66	24.03	66.25	2.45	109	4.72	33.54	22.00	60.25	2.23	102

PLEASE NOTE: DESIGN B HAS BEEN DISCONTINUED

ALL CONCRETE SHALL BE 4,000 PSI (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)



- TOP OF FOOTING

DRAWING NUMBER  
**E 305.1.0**

# CANTILEVER RETAINING WALLS DENSE FOUNDATION SOILS, SLOPING BACKFILL

TABLE OF DIMENSIONS AND REINFORCING STEEL

H	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
W	8,500	9,000	10,000	10,500	11,000	12,000	12,500	13,000	13,500	14,000	15,000	15,500	16,500	17,500	18,000	19,000	20,000
T	2,000	2,000	2,000	2,000	2,000	2,000	2,500	2,500	3,000	3,000	3,500	3,500	4,000	4,000	4,500	4,500	5,000
A	1,500	1,500	2,000	2,000	1,500	2,000	2,000	2,000	2,000	2,000	2,500	2,500	3,000	3,500	4,000	4,500	5,000
B	2,500	2,583	2,667	2,750	2,833	2,917	2,958	3,042	3,083	3,167	3,208	3,292	3,333	3,417	3,458	3,542	3,583
C	4,500	4,917	5,333	5,750	6,667	7,083	7,542	7,958	8,417	8,833	9,292	9,708	10,167	10,583	10,542	10,958	11,417
L	3,600	3,900	5,600	6,000	8,000	8,500	8,750	9,250	9,500	12,000	12,300	12,900	13,200	13,800	14,100	14,700	15,000
M	1,917	2,500	3,167	4,083	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
N	1,000	1,000	1,000	1,000	1,250	1,250	1,250	1,250	1,250	1,500	1,500	1,500	1,917	1,917	1,917	1,917	1,917
P	1,000	1,000	1,250	1,250	1,000	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,500	1,917	1,917	2,500	2,500
HOOK	1,000	1,167	1,167	1,333	1,333	1,583	1,583	1,833	1,833	1,833	2,000	2,000	1,583	1,583	1,583	1,583	1,833
A bars	6 @ 12	7 @ 12	7 @ 12	8 @ 12	8 @ 12	9 @ 12	9 @ 12	10 @ 12	10 @ 12	10 @ 12	11 @ 12	11 @ 12	9 @ 6	9 @ 6	9 @ 6	9 @ 6	10 @ 6
B bars	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12
C bars	7 @ 18	8 @ 18	9 @ 18	10 @ 18	11 @ 17	11 @ 14	11 @ 15.5	11 @ 13	11 @ 13.5	11 @ 12	11 @ 12	11 @ 10.5	11 @ 10.5	11 @ 9.5	11 @ 10.5	11 @ 9.5	11 @ 9.5
D bars	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	6 @ 18	6 @ 18	6 @ 18	7 @ 18	7 @ 18	7 @ 18	7 @ 18	7 @ 18
E bars	4 @ 18	4 @ 18	5 @ 18	5 @ 18	4 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	6 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18

Quantities of Materials

Stem Concrete (yd <sup>3</sup> /ft)	0.9	1.0	1.1	1.2	1.3	1.4	1.4	1.6	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4
Footings Concrete (yd <sup>3</sup> /ft)	0.6	0.7	0.7	0.8	0.8	0.9	1.2	1.2	1.5	1.6	2.0	2.0	2.5	2.6	3.0	3.2	3.7
Steel (lb/ft)	98	117	152	171	200	233	243	280	292	399	454	470	488	510	524	550	631

Maximum Soil Bearing Pressure

Q <sub>max</sub> (psf)	5123	5663	5432	5954	7019	6759	7346	7886	8482	9033	8817	9355	9178	8984	9103	8948	8892
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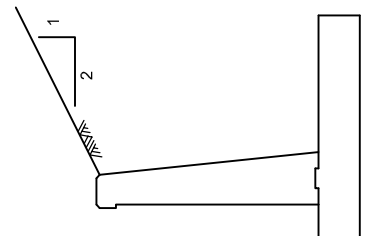
Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

ASSUMED DESIGN PARAMETERS

DENSE FOUNDATION SOIL, SLOPING BACKFILL

1. BACKFILL LOADING CONDITIONS:  
2H:1V SLOPING BACKFILL
2. BACKFILL SOIL PROPERTIES:  
TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES  
Ø = ANGLE OF INTERNAL FRICTION = 37°  
δ = ANGLE OF WALL FRICTION = 22°  
γ = EFFECTIVE UNIT WEIGHT = 120 pcf
3. FOUNDATION SOIL PROPERTIES:  
q<sub>f</sub> = FACTORED BEARING CAPACITY = 9400 psf  
FRICTION FACTOR = 0.57  
Ø<sub>SLIDING</sub> = PERFORMANCE FACTOR FOR SLIDING = 0.80
4. SEISMIC LOADING:  
A = 0.17g (Max.)  
K<sub>h</sub> = 0.085  
K<sub>v</sub> = 0
5. REINFORCED CONCRETE:  
F<sub>c</sub> = 4000 psi  
F<sub>y</sub> = 60000 psi  
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)



# CANTILEVER RETAINING WALLS DENSE FOUNDATION SOILS, LEVEL BACKFILL, SURCHARGE

TABLE OF DIMENSIONS AND REINFORCING STEEL

H	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
W	7.000	7.500	8.000	8.500	9.000	9.000	9.500	10.000	10.500	11.000	11.000	11.500	12.000	12.500	13.000	13.000	13.500
T	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	2.500
A	2.500	2.500	2.500	2.500	3.000	3.000	3.000	3.000	3.500	3.500	3.500	4.000	4.000	4.000	4.500	4.500	4.500
B	2.500	2.583	2.667	2.750	2.833	2.917	3.000	3.083	3.167	3.250	3.333	3.417	3.500	3.583	3.667	3.708	3.792
C	2.000	2.417	2.833	3.250	3.167	3.083	3.500	3.917	3.833	4.250	4.167	4.083	4.500	4.917	4.833	4.792	5.208
L	2.400	2.600	4.200	4.500	6.400	6.800	7.200	9.500	10.000	10.500	11.000	13.800	14.400	15.000	15.600	15.900	16.500
M	1.000	1.000	1.000	1.250	1.250	1.250	1.500	1.917	1.917	2.500	2.500	2.500	3.167	4.083	4.083	3.167	4.083
N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.250	1.250	1.250	1.250	1.250	1.250
P	1.250	1.250	1.250	1.250	1.500	1.500	1.917	1.917	2.500	2.500	2.500	3.167	4.083	4.083	5.000	4.083	4.083
HOOK	0.833	1.000	1.000	1.000	1.000	1.167	1.333	1.333	1.333	1.583	1.583	1.833	1.833	1.833	1.833	2.000	2.000
A bars	5 @ 12	6 @ 12	6 @ 12	6 @ 12	6 @ 12	7 @ 12	8 @ 12	8 @ 12	8 @ 12	9 @ 12	9 @ 12	10 @ 12	10 @ 12	10 @ 12	10 @ 12	11 @ 12	11 @ 12
B bars	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12
C bars	4 @ 18	4 @ 18	4 @ 16	5 @ 18	5 @ 18	5 @ 18	6 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18	8 @ 18	9 @ 18	10 @ 18	10 @ 18	9 @ 18	10 @ 18
D bars	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18
E bars	5 @ 18	5 @ 18	5 @ 18	5 @ 18	6 @ 18	6 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18	8 @ 18	9 @ 18	10 @ 18	10 @ 18	11 @ 18	10 @ 18	10 @ 18

Quantities of Materials

Stem Concrete (yd <sup>3</sup> /ft)	0.9	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.7
Footings Concrete (yd <sup>3</sup> /ft)	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.2	1.3
Steel (lb/ft)	76	86	96	104	118	133	161	182	198	233	240	307	340	360	388	412	438

Maximum Soil Bearing Pressure

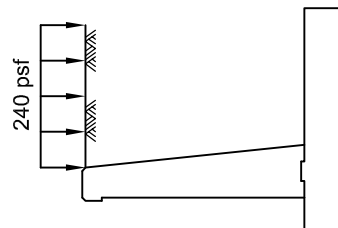
Q <sub>max</sub> (psf)	4071	4328	4591	4860	4811	5491	5752	6018	5945	6208	6917	6833	7090	7352	7271	8079	8332
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Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

ASSUMED DESIGN PARAMETERS

DENSE FOUNDATION SOIL, LEVEL BACKFILL, SURCHARGE



1. BACKFILL LOADING CONDITIONS:  
LEVEL BACKFILL:  
240 psf LIVE LOAD SURCHARGE.
2. BACKFILL SOIL PROPERTIES:  
TYPE: GRAVEL BORROW FOR  
BACKFILLING STRUCTURES AND PIPES  
 $\phi$  = ANGLE OF INTERNAL FRICTION = 37°  
 $\delta$  = ANGLE OF WALL FRICTION = 22°  
 $\gamma$  = EFFECTIVE UNIT WEIGHT = 120 pcf
3. FOUNDATION SOIL PROPERTIES:  
 $q_f$  = FACTORED BEARING CAPACITY = 9400 psf  
FRICTION FACTOR = 0.57  
 $\phi_{SLIDING}$  = PERFORMANCE FACTOR FOR SLIDING = 0.80
4. SEISMIC LOADING:  
 $A$  = 0.17g (Max.)  
 $K_h$  = 0.085  
 $K_v$  = 0
5. REINFORCED CONCRETE:  
 $F'_c$  = 4000 psi  
 $F_y$  = 60000 psi  
(SEE MASSDOT SPECIFICATIONS  
FOR DESIGN REQUIREMENTS)

# CANTILEVER RETAINING WALLS LOOSE FOUNDATION SOILS, SLOPING BACKFILL

DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 305.4.0**

TABLE OF DIMENSIONS AND REINFORCING STEEL																
H	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	30.0
W	10.000	11.000	11.500	13.000	14.000	15.000	15.500	16.500	17.500	18.500	20.000	20.500	22.000	23.000	24.000	26.000
T	2.000	2.000	2.000	2.500	2.500	3.000	3.000	3.500	3.500	4.000	4.000	4.500	4.500	5.000	5.000	6.000
A	1.000	1.000	1.000	2.000	2.500	2.500	2.500	3.000	3.500	4.000	5.000	5.000	6.000	6.500	7.000	8.000
B	2.500	2.583	2.667	2.708	2.792	2.833	2.917	2.958	3.042	3.083	3.167	3.208	3.292	3.333	3.375	3.500
C	6.500	7.417	7.833	8.292	8.708	9.667	10.083	10.542	10.958	11.417	11.833	12.292	12.708	13.167	13.625	14.500
L	3.600	3.900	5.600	5.800	6.200	6.400	8.500	8.750	9.250	9.500	10.000	10.250	10.750	13.200	13.500	14.400
M	4.083	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
N	1.000	1.250	1.250	1.250	1.500	1.500	1.500	1.917	1.917	1.917	1.917	1.917	2.500	2.500	3.167	3.167
P	1.000	1.000	1.000	1.000	1.250	1.000	1.250	1.250	1.500	1.500	1.917	1.917	2.500	2.500	2.500	3.167
HOOK	1.000	1.167	1.167	1.167	1.333	1.333	1.583	1.583	1.833	1.833	2.000	2.000	2.000	1.583	1.583	1.583
A bars	6 @ 12	7 @ 12	7 @ 12	7 @ 12	8 @ 12	8 @ 12	9 @ 12	9 @ 12	10 @ 12	10 @ 12	11 @ 12	11 @ 12	11 @ 12	9 @ 6	9 @ 6	9 @ 6
B bars	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12
C bars	10 @ 18	11 @ 15.5	11 @ 13	11 @ 14.5	11 @ 12.5	11 @ 11.5	11 @ 10	11 @ 10.5	11 @ 9	11 @ 9	11 @ 8	11 @ 8.5	11 @ 7.5	11 @ 7.5	11 @ 7.5	11 @ 6.5
D bars	4 @ 18	5 @ 18	5 @ 18	5 @ 18	6 @ 18	6 @ 18	6 @ 18	7 @ 18	7 @ 18	7 @ 18	7 @ 16	7 @ 16	8 @ 18	8 @ 18	9 @ 18	9 @ 18
E bars	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	4 @ 18	5 @ 18	5 @ 18	6 @ 18	6 @ 18	7 @ 16	7 @ 16	8 @ 18	8 @ 18	9 @ 18	9 @ 18

## Quantities of Materials

Stem Concrete (yd <sup>3</sup> /ft)	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.6	1.6	1.7	1.8	1.9	2.0	2.2	2.2
Footing Concrete (yd <sup>3</sup> /ft)	0.7	0.8	0.9	1.2	1.3	1.7	1.7	2.1	2.3	2.7	3.0	3.4	3.7	4.3	4.9	5.8
Steel (lb/ft)	126	158	173	189	219	309	351	379	422	440	500	516	557	588	625	664

## Maximum Soil Bearing Pressure

Q <sub>max</sub> (psf)	4918	5231	5737	5064	4998	5371	5816	5814	5771	5807	5387	5847	5473	5567	5667	5797
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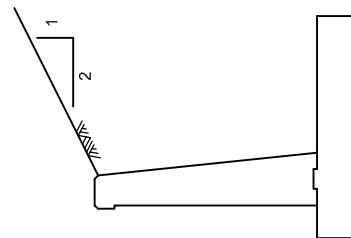
## Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

## ASSUMED DESIGN PARAMETERS

### LOOSE FOUNDATION SOIL, SLOPING BACKFILL

1. BACKFILL LOADING CONDITIONS:  
2H:1V SLOPING BACKFILL
2. BACKFILL SOIL PROPERTIES:  
TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES  
Ø = ANGLE OF INTERNAL FRICTION = 37°  
δ = ANGLE OF WALL FRICTION = 22°  
γ = EFFECTIVE UNIT WEIGHT = 120 pcf
3. FOUNDATION SOIL PROPERTIES:  
q<sub>t</sub> = FACTORED BEARING CAPACITY = 6000 psf  
FRICTION FACTOR = 0.50  
Ø<sub>SLIDING</sub> = PERFORMANCE FACTOR FOR SLIDING = 0.80
5. REINFORCED CONCRETE:  
F'<sub>C</sub> = 4000 psi  
F<sub>y</sub> = 60000 psi  
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)





# CANTILEVER RETAINING WALLS LOOSE FOUNDATION SOILS, LEVEL BACKFILL, SURCHARGE

TABLE OF DIMENSIONS AND REINFORCING STEEL

	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
<b>H</b>	7.500	8.000	8.000	8.500	9.000	9.500	10.000	10.500	11.000	11.500	12.000	13.000	13.500	14.000	15.000	15.500	16.000
<b>W</b>	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	2.500	2.500	2.500
<b>T</b>	1.500	1.500	1.750	2.000	2.500	2.500	2.500	3.000	3.000	3.500	3.750	4.250	4.500	5.000	5.500	5.500	6.000
<b>A</b>	2.500	2.583	2.667	2.750	2.833	2.917	3.000	3.083	3.167	3.250	3.333	3.417	3.500	3.542	3.625	3.750	3.875
<b>B</b>	3.500	3.917	3.583	3.750	3.667	4.083	4.500	4.417	4.833	4.750	4.917	5.333	5.500	5.458	5.875	6.250	6.125
<b>C</b>																	
<b>L</b>	2.400	2.600	4.200	4.500	6.400	6.800	7.200	9.500	10.000	10.500	11.000	11.500	14.400	14.700	15.300	15.900	16.500
<b>M</b>	1.250	1.500	1.500	1.500	1.500	1.917	2.500	2.500	3.167	3.167	3.167	4.083	4.083	3.167	4.083	5.000	5.000
<b>N</b>	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.250	1.250	1.250	1.250	1.500	1.250	1.500	1.500	1.500
<b>P</b>	1.000	1.000	1.000	1.000	1.250	1.250	1.500	1.917	1.917	2.500	2.500	3.167	4.083	3.167	4.083	4.083	5.000
<b>HOOK</b>	0.833	0.833	1.000	1.000	1.167	1.167	1.167	1.333	1.333	1.583	1.583	1.583	1.833	1.833	2.000	2.000	2.000
<b>A bars</b>	5 @ 12	5 @ 12	6 @ 12	6 @ 12	7 @ 12	7 @ 12	7 @ 12	8 @ 12	8 @ 12	9 @ 12	9 @ 12	9 @ 12	10 @ 12	10 @ 12	11 @ 12	11 @ 12	11 @ 12
<b>B bars</b>	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12
<b>C bars</b>	5 @ 18	6 @ 18	6 @ 18	6 @ 18	6 @ 18	7 @ 18	8 @ 18	8 @ 18	9 @ 18	9 @ 18	9 @ 18	10 @ 18	10 @ 16	9 @ 16	10 @ 18	11 @ 18	11 @ 18
<b>D bars</b>	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	6 @ 18	5 @ 18	6 @ 18	6 @ 18	6 @ 18
<b>E bars</b>	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	5 @ 18	6 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18	9 @ 18	10 @ 18	9 @ 18	10 @ 18	10 @ 18	11 @ 18

Quantities of Materials

<b>Stem Concrete (yd<sup>3</sup>/ft)</b>	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.1	2.3	2.4	2.6	2.7
<b>Footings Concrete (yd<sup>3</sup>/ft)</b>	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.3	1.4	1.4	1.5
<b>Steel (lb/ft)</b>	79	86	101	106	130	141	157	191	211	246	257	287	365	343	435	463	492
<b>Q<sub>max</sub> (psf)</b>	4318	4614	5111	5210	5133	5412	5693	5616	5893	5824	5929	5558	5670	5733	5440	5695	5687

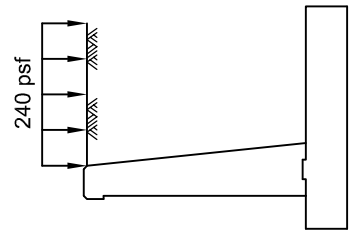
Maximum Soil Bearing Pressure

Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

ASSUMED DESIGN PARAMETERS

LOOSE FOUNDATION SOIL, LEVEL BACKFILL, SURCHARGE



1. BACKFILL LOADING CONDITIONS:

LEVEL BACKFILL;  
240 psf LIVE LOAD SURCHARGE.

2. BACKFILL SOIL PROPERTIES:

TYPE: GRAVEL BORROW FOR  
BACKFILLING STRUCTURES AND PIPES

$\phi$  = ANGLE OF INTERNAL FRICTION = 37°

$\delta$  = ANGLE OF WALL FRICTION = 22°

$\gamma$  = EFFECTIVE UNIT WEIGHT = 120 pcf

3. FOUNDATION SOIL PROPERTIES:

$q_t$  = FACTORED BEARING CAPACITY = 6000 psf

FRICTION FACTOR = 0.5

$\phi_{SLIDING}$  = PERFORMANCE FACTOR FOR SLIDING = 0.80

4. SEISMIC LOADING:

A = 0.17g (Max.)

$K_h$  = 0.085

$K_v$  = 0

5. REINFORCED CONCRETE:

$F'_c$  = 4000 psi

$F_y$  = 60000 psi

(SEE MASSDOT SPECIFICATIONS  
FOR DESIGN REQUIREMENTS)

# CANTILEVER RETAINING WALLS ROCK FOUNDATION, SLOPING BACKFILL

DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 305.6.0**

TABLE OF DIMENSIONS AND REINFORCING STEEL

H	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
W	8.500	9.000	9.000	9.500	10.000	10.500	11.000	11.500	12.000	13.000	13.500	14.000	14.500	15.000	15.500	16.000	16.500
T	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	2.500	2.500	2.500	2.500	2.500	3.000	3.000	3.500
A	1.500	2.000	2.500	3.000	3.000	3.500	3.500	4.000	4.500	4.500	4.500	5.000	5.000	5.000	5.500	6.000	6.000
B	2.500	2.583	2.667	2.750	2.833	2.917	3.000	3.083	3.125	3.208	3.292	3.375	3.458	3.542	3.583	3.667	3.708
C	4.500	4.417	3.833	3.750	4.167	4.083	4.500	4.417	4.375	5.292	5.708	5.625	6.042	5.958	6.417	6.333	6.792
L	3.600	3.900	5.600	6.000	8.000	8.500	9.000	11.400	11.700	12.300	12.900	13.500	16.450	17.150	17.500	18.200	18.550
M	1.917	1.917	1.917	1.917	1.917	1.917	2.500	2.500	1.917	3.167	4.083	4.083	5.000	5.000	5.000	5.000	5.000
N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.250	1.000	1.250	1.250	1.250	1.250	1.250	1.500	1.250	1.500
P	1.000	1.000	1.250	1.917	1.917	2.500	2.500	3.167	3.167	3.167	4.083	4.083	5.000	5.000	5.000	5.000	5.000
HOOK	1.000	1.167	1.167	1.333	1.333	1.583	1.583	1.833	1.833	2.000	2.000	1.583	1.583	1.833	1.833	1.833	1.833
A bars	6 @ 12	7 @ 12	7 @ 12	8 @ 12	8 @ 12	9 @ 12	9 @ 12	10 @ 12	10 @ 12	11 @ 12	11 @ 12	9 @ 6	9 @ 6	10 @ 6	10 @ 6	10 @ 6	10 @ 6
B bars	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12
C bars	7 @ 18	7 @ 18	7 @ 18	7 @ 18	7 @ 18	7 @ 17	8 @ 18	8 @ 18	7 @ 17	9 @ 18	10 @ 18	10 @ 18	11 @ 18	11 @ 18	11 @ 18	11 @ 18	11 @ 18
D bars	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	4 @ 18	5 @ 18	5 @ 18	5 @ 17	5 @ 18	5 @ 16	6 @ 18	5 @ 15	6 @ 17
E bars	4 @ 18	4 @ 18	5 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18	9 @ 18	9 @ 18	9 @ 18	10 @ 18	10 @ 17	11 @ 18	11 @ 16	11 @ 18	11 @ 15	11 @ 17

Quantities of Materials

Stern Concrete (yd <sup>3</sup> /ft)	0.9	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.5	2.7
Footing Concrete (yd <sup>3</sup> /ft)	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.9	1.1	1.2	1.3	1.3	1.3	1.4	1.7	1.8	2.1
Steel (lb/ft)	98	120	125	148	164	197	213	272	276	342	379	382	446	503	543	558	580
Q <sub>max</sub> (psf)	5123	5161	5481	5530	6053	6103	6626	6677	6838	7053	7562	7625	8134	8197	8802	8870	9475

Maximum Soil Bearing Pressure

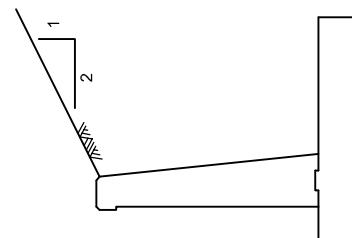
Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

ASSUMED DESIGN PARAMETERS

ROCK FOUNDATION, SLOPING BACKFILL

1. BACKFILL LOADING CONDITIONS:  
2H:1V SLOPING BACKFILL
2. BACKFILL SOIL PROPERTIES:  
TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES  
Ø = ANGLE OF INTERNAL FRICTION = 37°  
δ = ANGLE OF WALL FRICTION = 22°  
γ = EFFECTIVE UNIT WEIGHT = 120 pcf
3. FOUNDATION SOIL PROPERTIES:  
q<sub>t</sub> = FACTORED BEARING CAPACITY = 20000 psf  
FRICTION FACTOR = 0.70  
Ø<sub>SLIDING</sub> = PERFORMANCE FACTOR FOR SLIDING = 0.80
4. SEISMIC LOADING:  
A = 0.17g (Max.)  
Kh = 0.085  
Kv = 0
5. REINFORCED CONCRETE:  
F'<sub>c</sub> = 4000 psi  
F<sub>y</sub> = 60000 psi  
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)



# **CANTILEVER RETAINING WALLS** **ROCK FOUNDATION,** **LEVEL BACKFILL, SURCHARGE**

**TABLE OF DIMENSIONS AND REINFORCING STEEL**

	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
<b>H</b>																	
<b>W</b>	7.000	7.500	8.000	8.500	9.000	9.000	9.500	10.000	10.500	11.000	11.000	11.500	12.000	12.500	13.000	13.000	13.500
<b>T</b>	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	2.500
<b>A</b>	2.500	2.500	2.500	2.500	3.000	3.000	3.000	3.000	3.500	3.500	3.500	4.000	4.000	4.000	4.500	4.500	4.500
<b>B</b>	2.500	2.583	2.667	2.750	2.833	2.917	3.000	3.083	3.167	3.250	3.333	3.417	3.500	3.583	3.667	3.708	3.792
<b>C</b>	2.000	2.417	2.833	3.250	3.167	3.083	3.500	3.917	3.833	4.250	4.167	4.083	4.500	4.917	4.833	4.792	5.208
<b>L</b>	2.400	2.600	4.200	4.500	6.400	6.800	7.200	9.500	10.000	10.500	11.000	13.800	14.400	15.000	15.600	15.900	16.500
<b>M</b>	1.000	1.000	1.000	1.250	1.250	1.250	1.500	1.917	1.917	2.500	2.500	2.500	3.167	4.083	4.083	3.167	4.083
<b>N</b>	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.250	1.250	1.250	1.250	1.250	1.250
<b>P</b>	1.250	1.250	1.250	1.250	1.500	1.500	1.917	1.917	2.500	2.500	2.500	3.167	4.083	4.083	5.000	4.083	4.083
<b>HOOK</b>	0.833	1.000	1.000	1.000	1.000	1.167	1.333	1.333	1.333	1.583	1.583	1.833	1.833	1.833	1.833	2.000	2.000
<b>A bars</b>	5 @ 12	6 @ 12	6 @ 12	6 @ 12	6 @ 12	7 @ 12	8 @ 12	8 @ 12	8 @ 12	9 @ 12	9 @ 12	10 @ 12	10 @ 12	10 @ 12	10 @ 12	11 @ 12	11 @ 12
<b>B bars</b>	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12	4 @ 12
<b>C bars</b>	4 @ 18	4 @ 18	4 @ 16	5 @ 18	5 @ 18	5 @ 18	6 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18	8 @ 18	9 @ 18	10 @ 18	10 @ 18	9 @ 18	10 @ 18
<b>D bars</b>	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	4 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18	5 @ 18
<b>E bars</b>	5 @ 18	5 @ 18	5 @ 18	5 @ 18	6 @ 18	6 @ 18	7 @ 18	7 @ 18	8 @ 18	8 @ 18	8 @ 18	9 @ 18	10 @ 18	10 @ 18	11 @ 18	10 @ 18	10 @ 18

**Quantities of Materials**

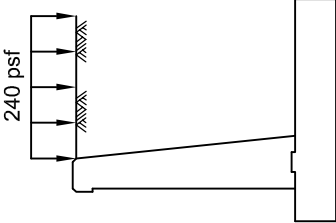
<b>Stem Concrete (yd<sup>3</sup>/ft)</b>	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.7
<b>Footing Concrete (yd<sup>3</sup>/ft)</b>	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.2	1.3
<b>Steel (lb/ft)</b>	76	85	96	104	118	133	176	182	198	233	240	307	340	360	388	412	438
<b>Q<sub>max</sub> (psf)</b>	4071	4328	4591	4860	4811	5491	5752	6018	5945	6208	6917	6833	7090	7352	7271	8079	8332

**Maximum Soil Bearing Pressure**

**Notes:**

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

**ASSUMED DESIGN PARAMETERS**  
**ROCK FOUNDATION, LEVEL BACKFILL, SURCHARGE**



240 psf

1. BACKFILL LOADING CONDITIONS:  
 LEVEL BACKFILL;  
 240 psf LIVE LOAD SURCHARGE.

2. BACKFILL SOIL PROPERTIES:  
 TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES  
 $\phi =$  ANGLE OF INTERNAL FRICTION = 37°  
 $\delta =$  ANGLE OF WALL FRICTION = 22°  
 $\gamma =$  EFFECTIVE UNIT WEIGHT = 120 pcf

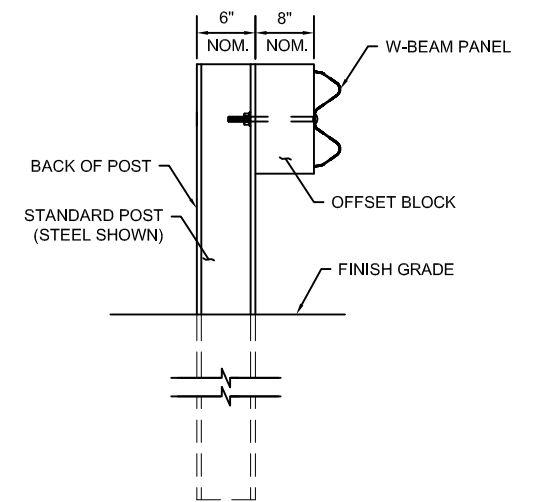
3. FOUNDATION SOIL PROPERTIES:  
 $q_t =$  FACTORED BEARING CAPACITY = 20000 psf  
 FRICTION FACTOR = 0.70  
 $\phi_{SLIDING} =$  PERFORMANCE FACTOR FOR SLIDING = 0.80

4. SEISMIC LOADING:  
 $A = 0.17g$  (Max.)  
 $K_h = 0.085$   
 $K_v = 0$

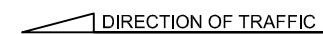
5. REINFORCED CONCRETE:  
 $F'_c = 4000$  psi  
 $F_y = 60000$  psi  
 (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

**NOTES:**

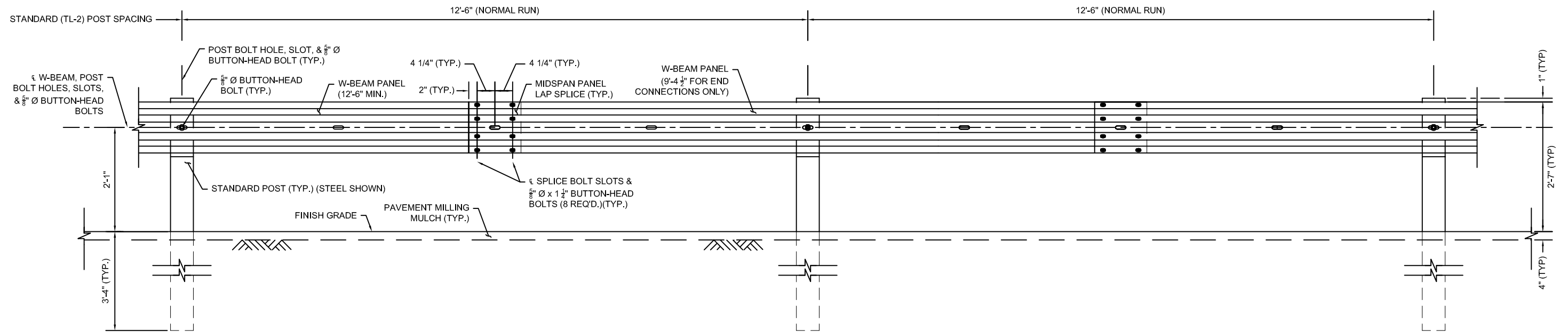
1. ALL DIMENSIONS OF STANDARD GUARDRAIL COMPONENTS, INCLUDING PANELS, POSTS, OFFSET BLOCKS, BOLTS, NUTS, WASHERS AND HOLES, ARE BASED UPON ENGLISH UNIT CONVERSIONS OF THE AASHTO-ARTBA-AGC JOINT COMMITTEE TASK FORCE 13 REPORT: *A GUIDE TO STANDARDIZING HIGHWAY BARRIER HARDWARE* (<http://www.aashtotf13.org/Barrier-Hardware.php>).
2. ALL GUARDRAIL MATERIALS SHALL CONFORM TO M8.07.0 UNLESS OTHERWISE INDICATED.
3. APPROVAL BY THE ENGINEER IS REQUIRED WHERE A DIFFERING GUARDRAIL CONFIGURATION IS REQUIRED FOR CONSTRUCTABILITY BEYOND THE OPTIONS SHOWN IN THESE STANDARDS OR THE PLANS.
4. THE BEGIN OR END STATION LABELS SHOWN IN THESE STANDARDS CORRESPOND TO THE STATION AND OFFSET CALLOUTS SPECIFIED IN THE PLANS.
5. USE 12'-6" NOMINAL LENGTH PANELS UNLESS OTHERWISE INDICATED IN THESE STANDARDS OR THE PLANS.
6. ALL LAP SPLICES SHALL BE MIDSPAN UNLESS OTHERWISE SHOWN.
7. LAP SPLICES SHALL BE CONSTRUCTED WITH THE SPLICE RIDGE ORIENTED DOWNSTREAM OF THE FINAL DIRECTION OF TRAFFIC IN THE NEAREST TRAVEL LANE. REORIENTING LAP SPLICES FOR TEMPORARY TRAFFIC CONTROL IS NOT REQUIRED.
8. STANDARD POSTS SHALL BE STEEL OR TIMBER, UNLESS OTHERWISE INDICATED IN THE PLANS, FABRICATED TO THE DIMENSIONS SHOWN ON 400.1.4. POSTS OF A SINGLE MATERIAL TYPE SHALL BE USED THROUGHOUT AN ENTIRE RUN OF GUARDRAIL; EXCEPTIONS ARE ALLOWED ONLY WHEN SPECIFIC MATERIAL TYPES ARE REQUIRED FOR TRANSITIONS, END TREATMENTS, AND/OR ANCHORAGES.
9. DEEP POST SHALL ONLY BE USED WHERE INDICATED IN THESE STANDARDS OR THE PLANS.
10. OFFSET BLOCKS, WHERE REQUIRED, SHALL BE TIMBER AND FABRICATED TO THE NOMINAL DIMENSIONS SHOWN ON 400.1.4. PLASTIC OR COMPOSITE OFFSET BLOCKS OF THE SAME NOMINAL DIMENSIONS THAT ARE LISTED ON THE QUALIFIED CONSTRUCTION MATERIALS LIST MAY BE SUBSTITUTED. OFFSET BLOCKS OF A SINGLE MATERIAL TYPE SHALL BE USED THROUGHOUT AN ENTIRE RUN OF GUARDRAIL; EXCEPTIONS ARE ALLOWED ONLY WHEN SPECIFIC MATERIAL TYPES ARE REQUIRED FOR TRANSITIONS, END TREATMENTS, AND/OR ANCHORAGES.
11. PAVEMENT MILLING MULCH, WHERE CALLED FOR IN THE STANDARDS, SHALL CONFORM TO SECTION 739.
12. GUARDRAIL DELINEATORS, CONFORMING TO SECTION 601, SHALL BE INSTALLED AT 25' INTERVALS WITHIN 100' OF AN END TREATMENT OR TRAILING ANCHORAGE AND AT 100' INTERVALS IN ALL OTHER AREAS UNLESS OTHERWISE SHOWN IN THE PLANS.
13. MINIMUM OFFSET DISTANCE FROM FACE OF W-BEAM PANEL TO A FIXED (NON-BREAKAWAY) OBJECT SHALL BE 48" FOR TL-2 AND 60" FOR TL-3.



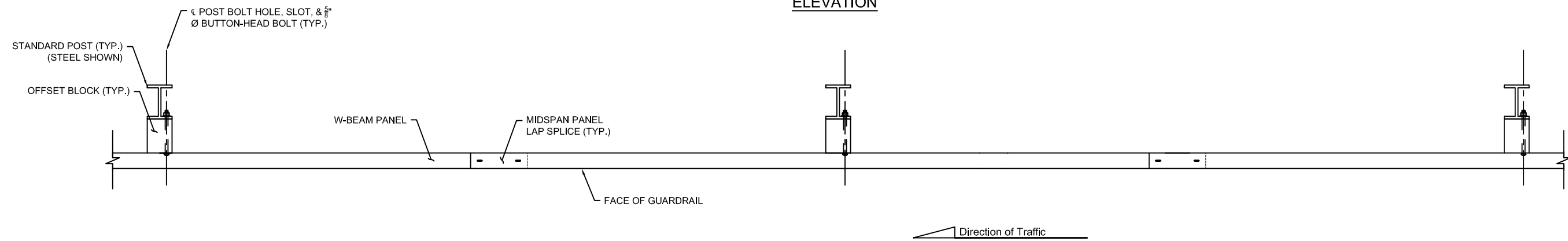
SECTION



## PLAN



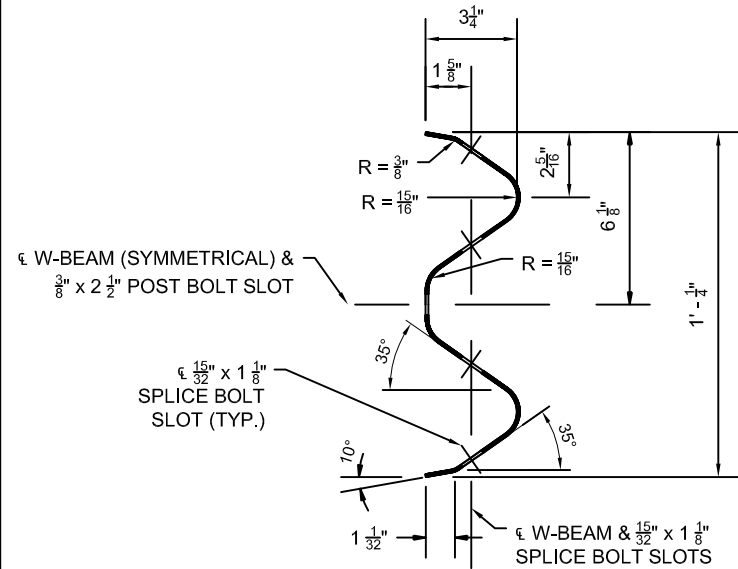
ELEVATION



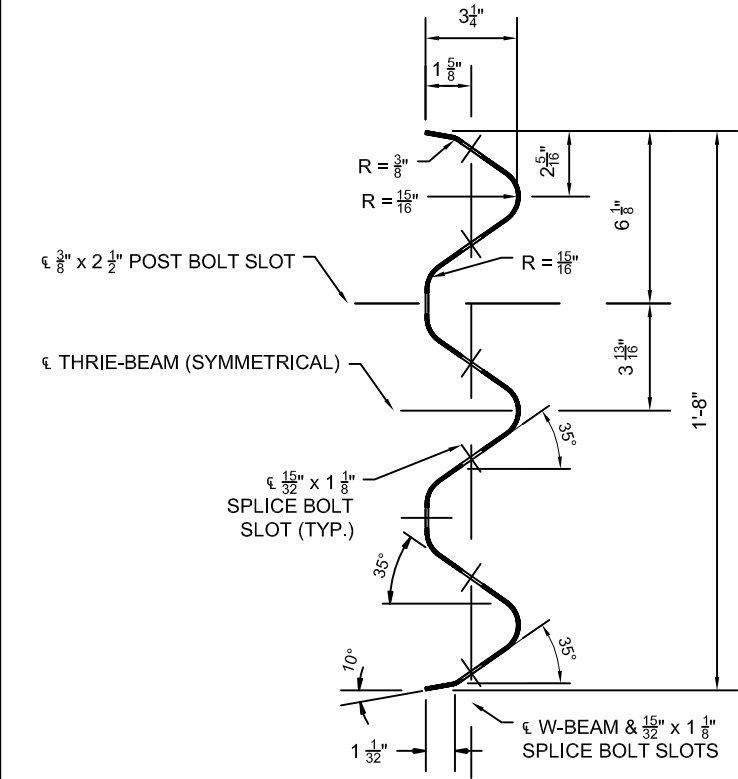
PLAN

NOTES:

1. A 9'-4 1/2" PANEL IS REQUIRED WHEN TRANSITIONING TO TL-3 W-BEAM GUARDRAIL TO MAINTAIN PROPER POST SPACING.



W-BEAM PANEL SECTION



THRIE-BEAM PANEL SECTION

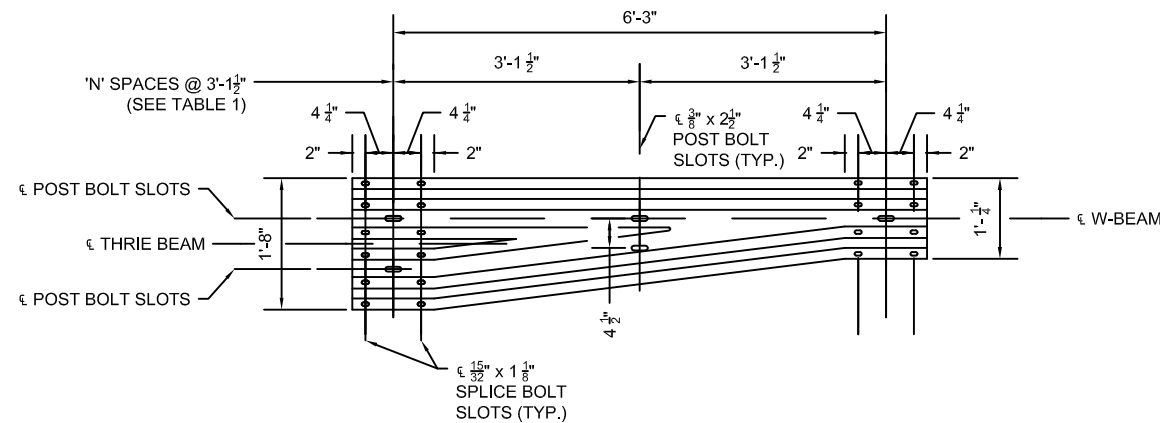
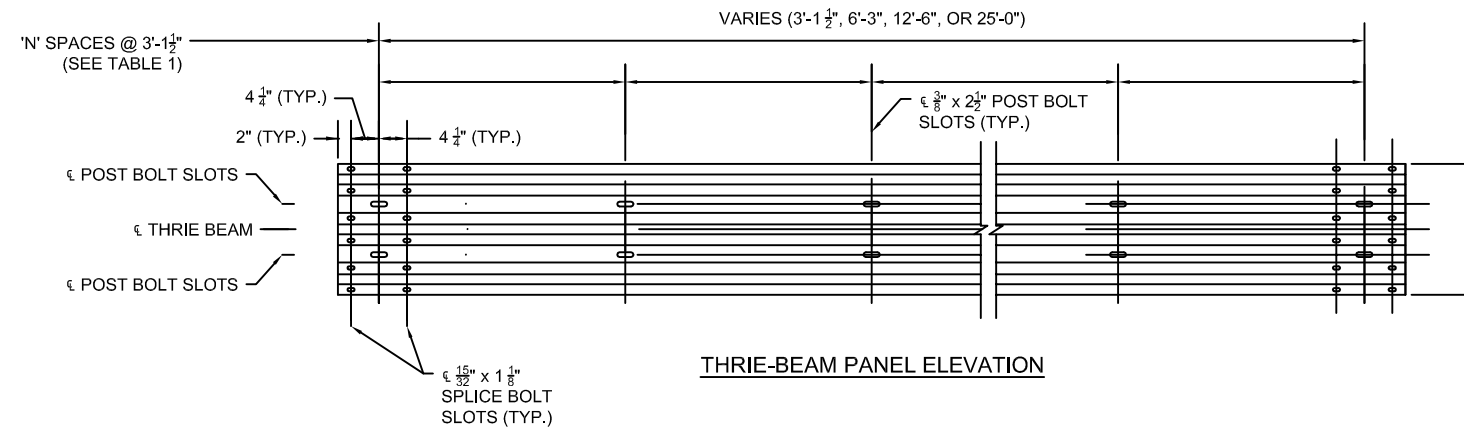
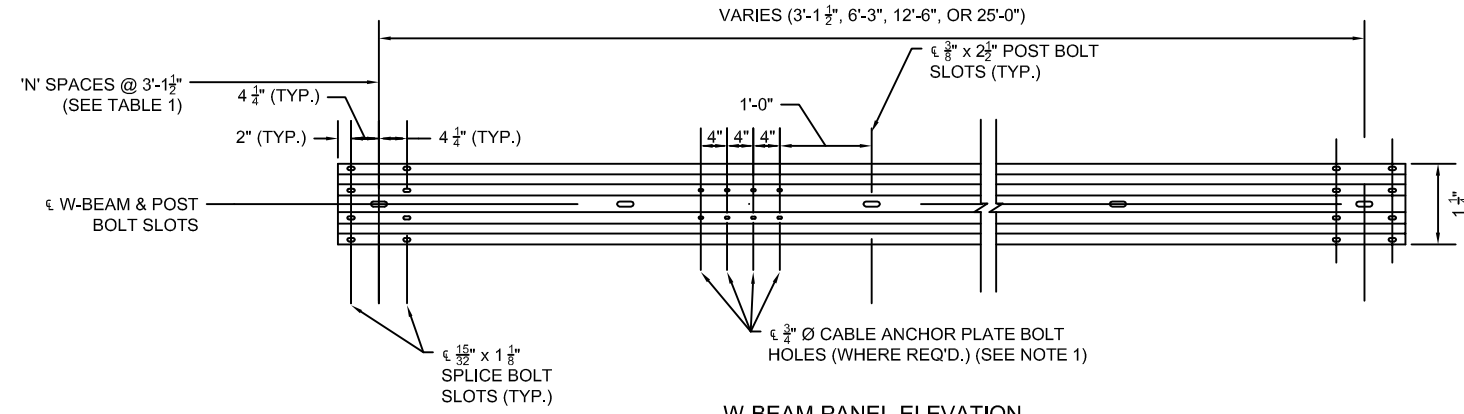


TABLE 1 : PANEL SUMMARY

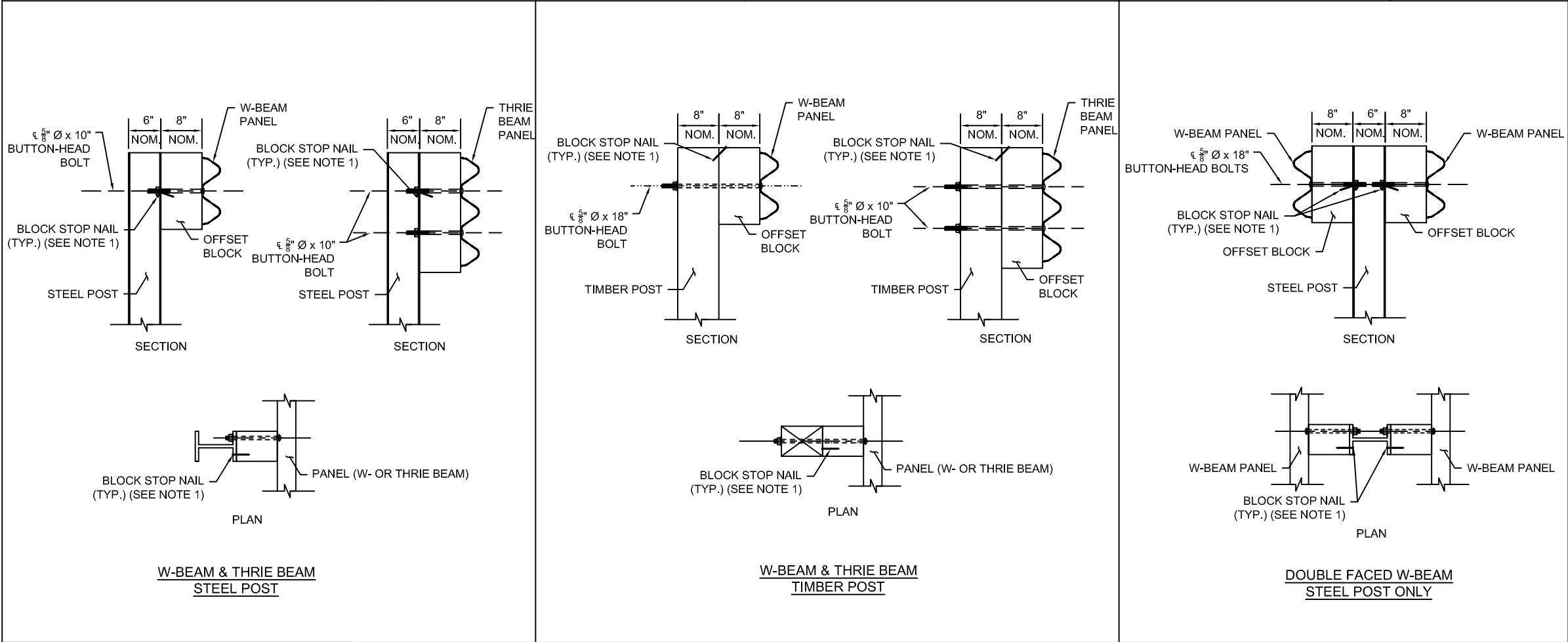
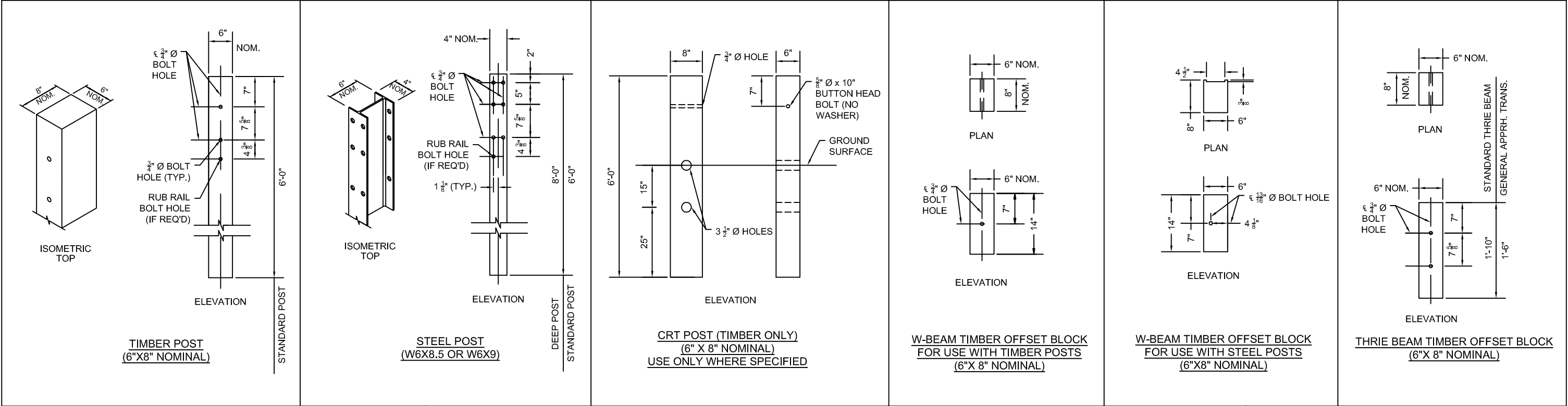
PANEL TYPE	NUMBER OF SPACES 'N'	GAUGE
6'-3" W-BEAM	2	12
9'-4 1/2" W-BEAM	3	12
12'-6" W-BEAM	4	12
25'-0" W-BEAM	8	12
12'-6" THRIE-BEAM	4	12
25'-0" THRIE BEAM	8	12
THRIE-BEAM TRANS.	2	10

TABLE 2 : 3/8" BUTTON-HEAD BOLT LENGTHS

APPLICATION(S)	LENGTH 'L'	MIN. THREAD LENGTH
PANEL SPLICE	1 3/4"	FULL LENGTH
STEEL POST MOUNT - SINGLE FACED	10"	4"
TIMBER POST MOUNT - SINGLE FACED	18"	4"
STEEL POST MOUNT - DOUBLE FACED	10"	4"
TERMINAL CONNECTOR SPLICE	2"	FULL LENGTH

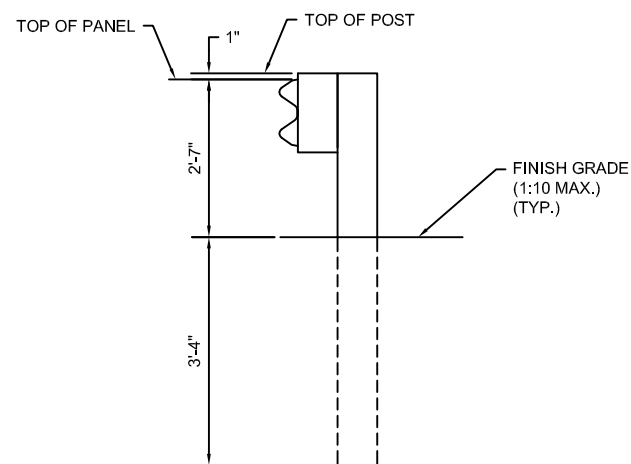
NOTES:

- INCLUDE 3/8" Ø CABLE ANCHOR PLATE BOLT HOLES ONLY WHERE REQUIRED FOR THE INSTALLATION OF THE CABLE ANCHOR PLATE SHOWN ON 400.4.1 AND 400.4.2.
- INSTALL BUTTON-HEAD BOLTS FOR POST MOUNTS AND SPLICES, AS REQUIRED. BOLT LENGTHS SHALL CONFORM TO TABLE 2 UNLESS OTHERWISE INDICATED. PLACE WASHERS UNDER NUTS; WASHERS ARE OPTIONAL AGAINST STEEL FLANGES. DO NOT PLACE WASHERS BETWEEN BOLT HEADS AND PANELS UNLESS OTHERWISE INDICATED.

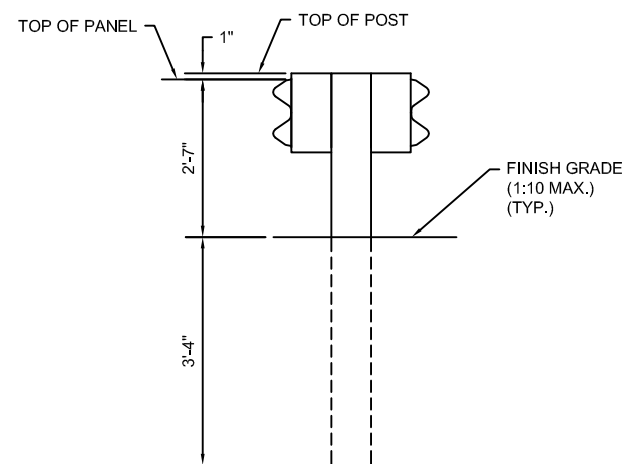


- NOTES:**
1. DRIVE ONE NAIL PER W BEAM TIMBER OFFSET BLOCK TO PREVENT BLOCK ROTATION. USE ASTM A153 HOT DIP GALVANIZED STEEL 3 1/2" TYPE 16D NAILS. FOR STEEL POSTS, DRIVE THE NAIL THROUGH THE UNUSED FLANGE BOLT HOLE AND BEND THE NAIL SO ITS HEAD CONTACTS THE FLANGE.
  2. DEEP STEEL POSTS SHALL ONLY BE USED WHERE INDICATED IN THESE STANDARDS OR THE PLANS.
  3. WHERE BACK OF POSTS ARE EXPOSED AND PLACED WITHIN 2'-0" OF A SIDEWALK, SEPARATED BIKE FACILITY OR SHARED-USE PATH, TIMBER POSTS SHALL BE USED. ALTERNATIVELY, STEEL POSTS WITH A TIMBER BACKING, PER 400.5.1, MAY BE SUBSTITUTED AT NO ADDITIONAL COST. WHEN TIMBER POSTS ARE USED, ONE OF THE FOLLOWING SAFETY TREATMENTS IS REQUIRED FOR ALL BOLTS PROTRUDING FROM THE BACK FACE OF THE POST:
    - A. AFTER TIGHTENING THE NUT, TRIM THE PROTRUDING POST BOLT FLUSH WITH THE NUT AND GALVANIZE PER M7.04.11;
    - B. USE 15" POST BOLTS AND COUNTERSINK THE WASHER AND NUT BETWEEN 1" AND 1 1/2" DEEP INTO THE BACK FACE OF THE POST; OR
    - C. USE 15" POST BOLT SLEEVE NUTS AND WASHERS.END TREATMENTS AND TRANSITIONS, WHERE SPECIFIC MATERIAL TYPES ARE SPECIFIED, ARE EXEMPT FROM THESE REQUIREMENTS.

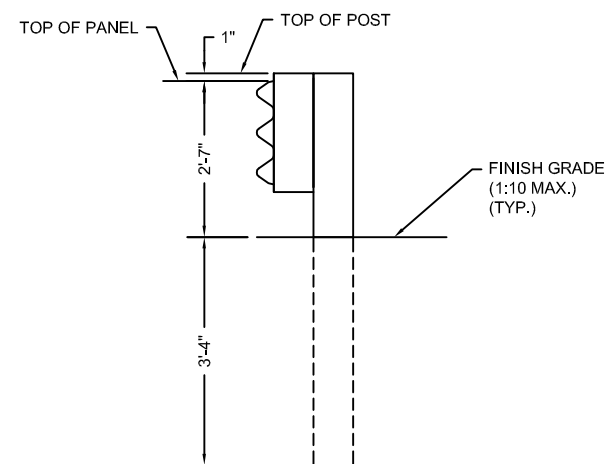




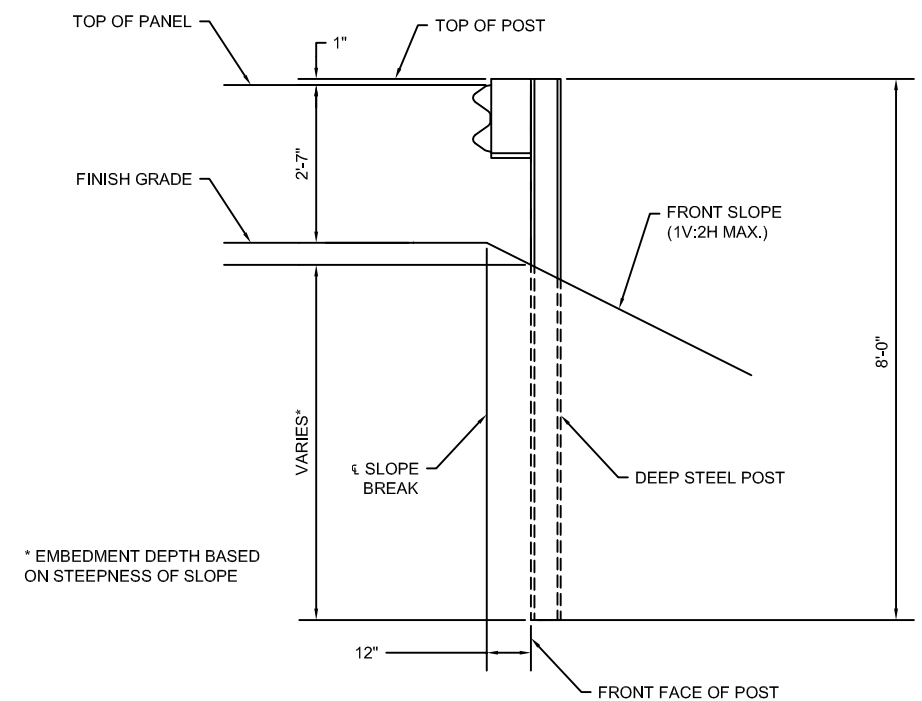
W-BEAM



DOUBLE FACED  
W-BEAM



THRIE-BEAM



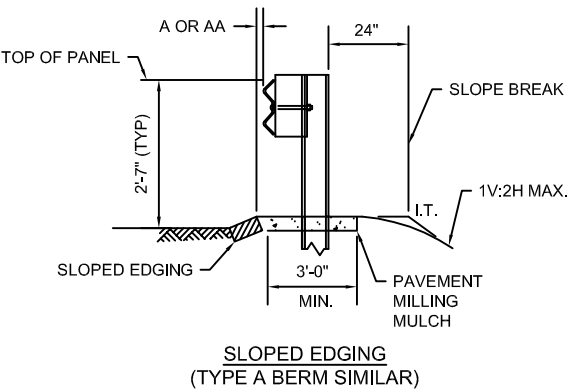
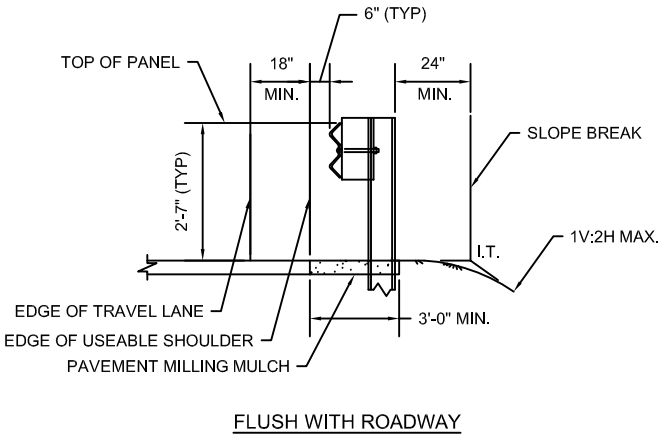
SLOPE BREAK CONDITION  
STEEL DEEP POST

\* EMBEDMENT DEPTH BASED  
ON STEEPNESS OF SLOPE

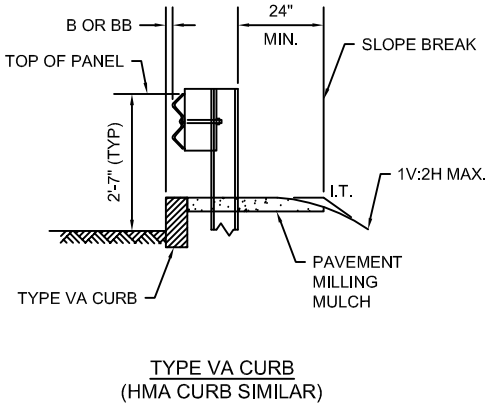
NOTES:

1. CONSTRUCTION TOLERANCE FOR PANEL HEIGHT =  $\pm 1"$ .

SINGLE FACED:

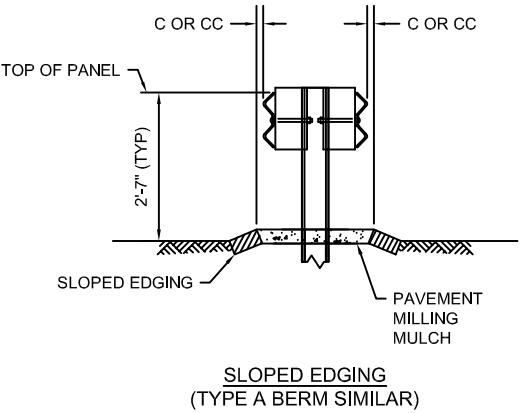
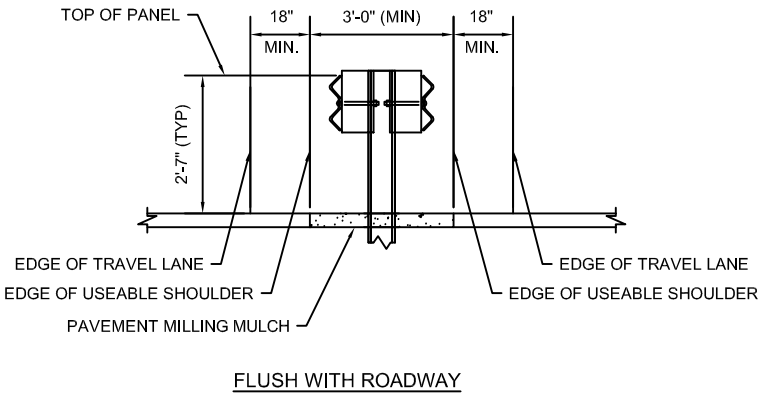


	TL-2	TL-3
A (AT FACE)	0" TO 6"	0" TO 6"
AA (OFFSET)	6'-0" (MIN)	N/A (SEE NOTE 5)

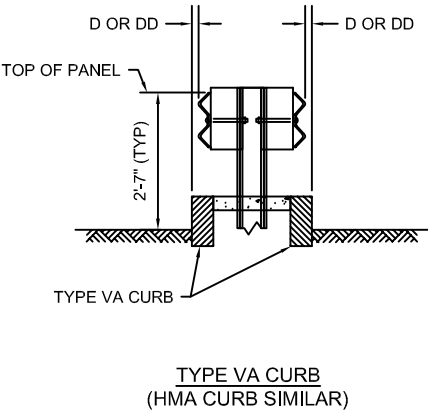


	TL-2	TL-3
B (AT FACE)	0" TO 6"	0" TO 6"
BB (OFFSET)	6'-0" (MIN)	N/A (SEE NOTE 5)

DOUBLE FACED:



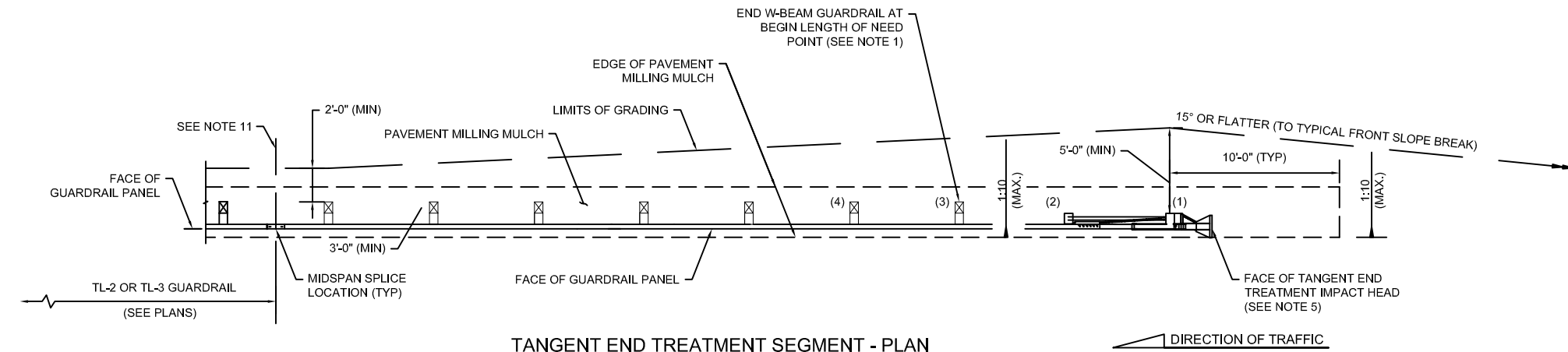
	TL-2	TL-3
C (AT FACE)	0" TO 10"	0" TO 10"
CC (OFFSET)	6'-0" (MIN)	13'-0" (MIN)



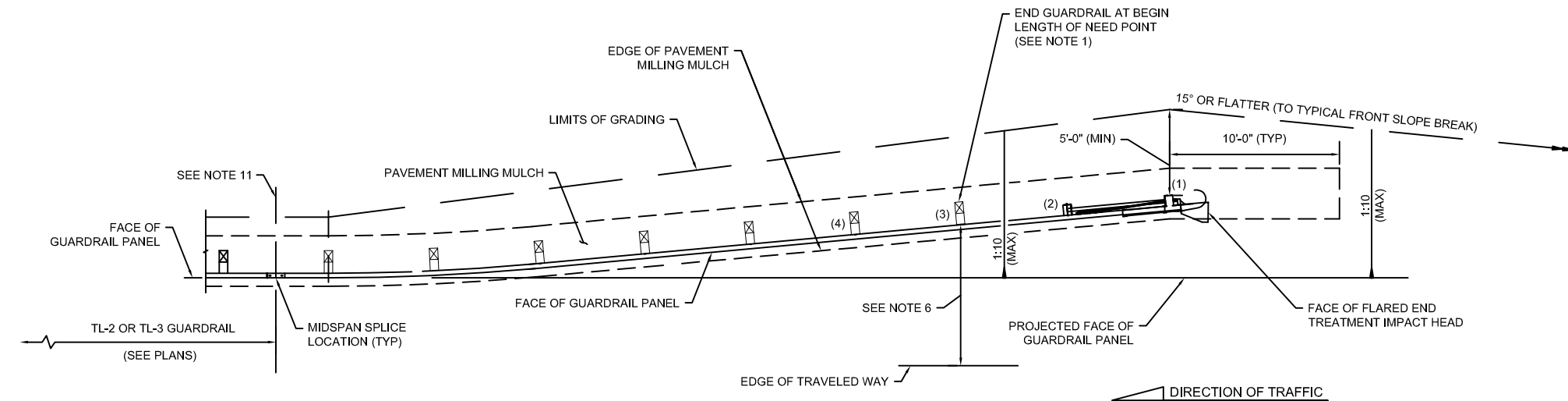
	TL-2	TL-3
D (AT FACE)	0" TO 10"	0" TO 10"
DD (OFFSET)	6'-0" (MIN)	N/A (SEE NOTE 5)

NOTES:

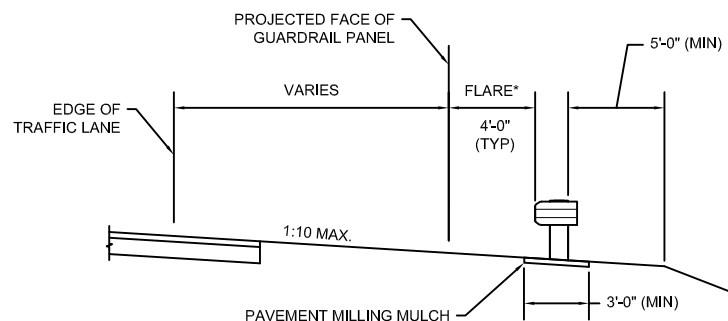
1. TYPE VA CURB PER E 106.3.0.
2. HMA CURB PER E 106.2.0.
3. SLOPED EDGING PER E 106.5.0.
4. TYPE A BERM PER E 106.1.0.
5. TL-3 GUARDRAIL SHALL NOT BE OFFSET FROM VERTICAL CURB AND SINGLE FACED TL-3 GUARDRAIL SHALL NOT BE OFFSET FROM SLOPED EDGING UNLESS OTHERWISE SHOWN IN THE PLANS OR THESE STANDARDS.
6. IN ORDER TO FACILITATE DESIGN AND CONSTRUCTION, THE OFFSET FROM THE CURB TO FACE OF GUARDRAIL DOES NOT HAVE TO BE SYMMETRICAL BETWEEN SIDES. ONE SIDE MAY BE LOCATED AT THE FACE OF CURB AND THE OPPOSITE MAY BE OFFSET.



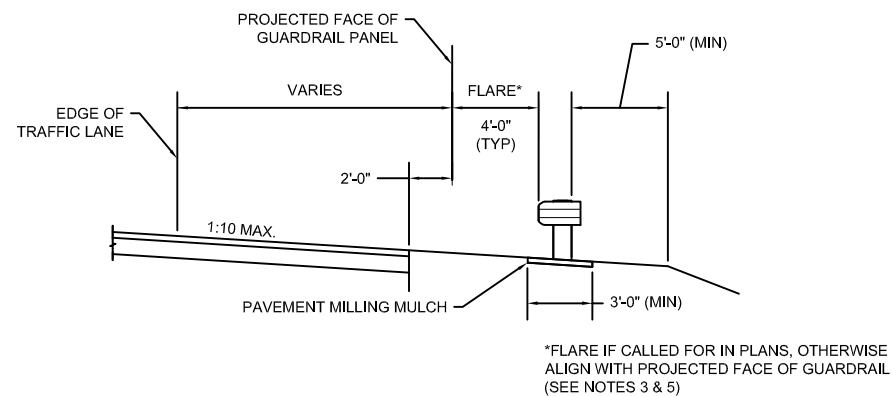
**TANGENT END TREATMENT SEGMENT - PLAN**



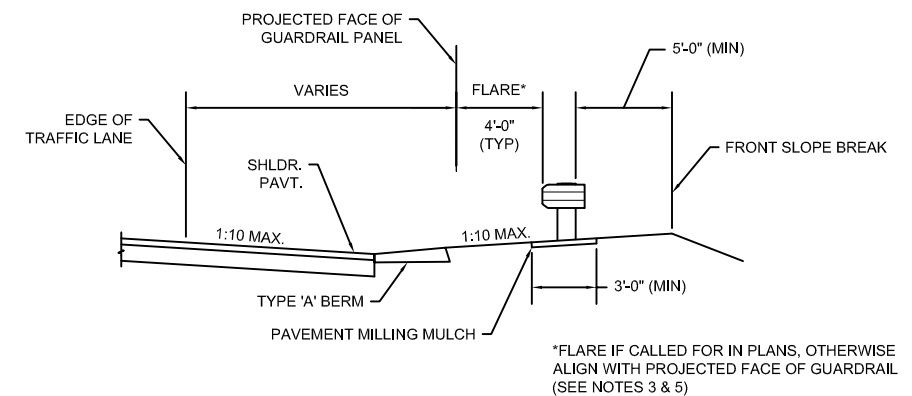
**FLARED END TREATMENT SEGMENT - PLAN**



**SECTION AT POST (1)  
WITH UNPAVED SHOULDER**



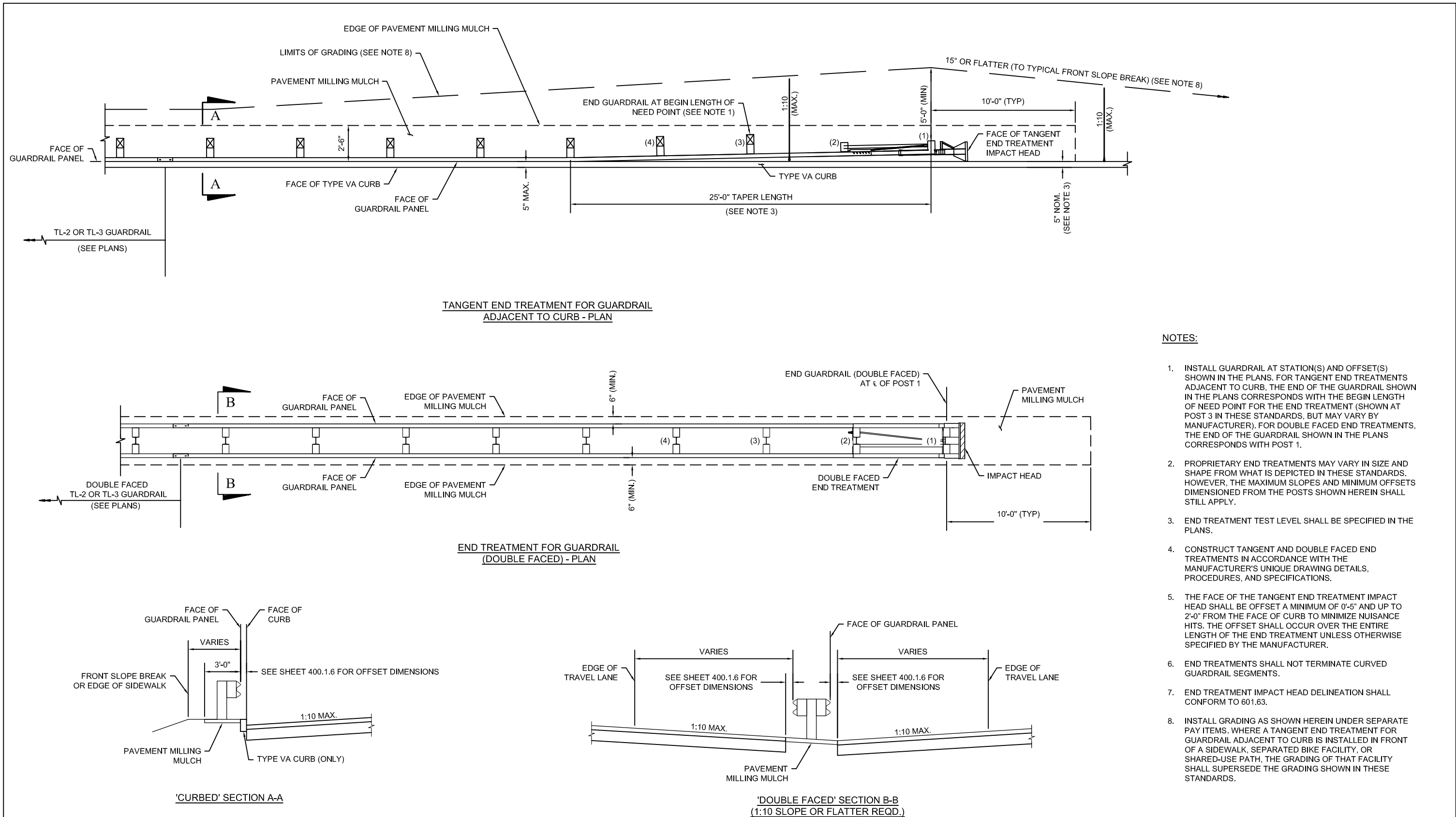
**SECTION AT POST (1)  
WITH FULLY PAVED SHOULDER**

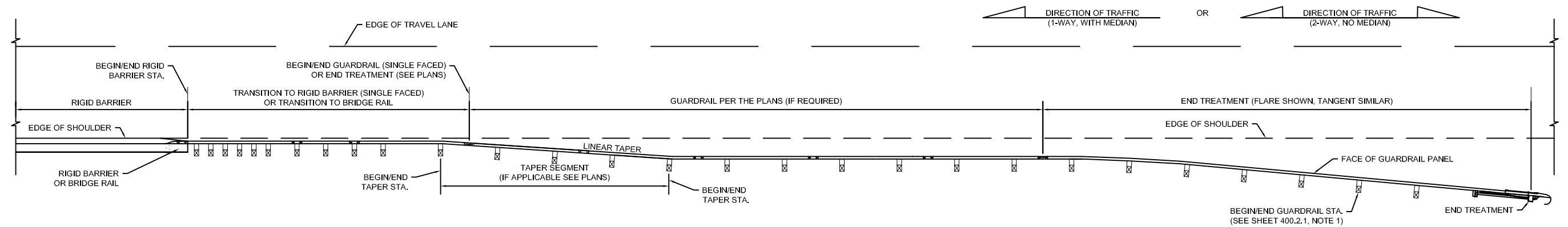


**SECTION AT POST (1)  
WITH TYPE 'A' BERM**

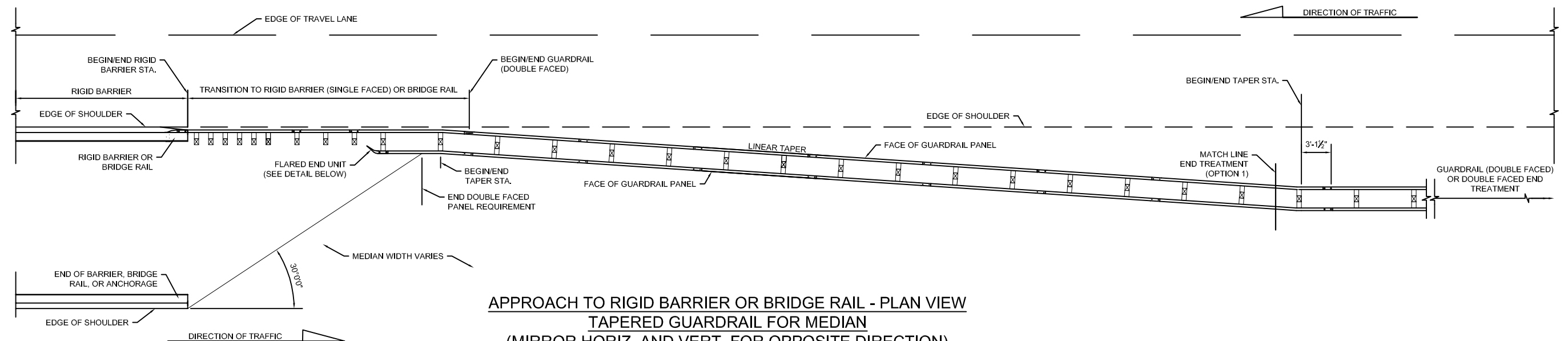
**NOTES:**

1. INSTALL GUARDRAIL AT STATION AND OFFSET SHOWN IN THE PLANS. THE END OF THE GUARDRAIL SHOWN IN THE PLANS CORRESPONDS WITH THE BEGIN LENGTH OF NEED POINT FOR THE END TREATMENT (SHOWN AT POST 3 IN THESE STANDARDS, BUT MAY VARY BY MANUFACTURER).
2. PROPRIETARY END TREATMENTS MAY VARY IN SIZE AND SHAPE FROM WHAT IS DEPICTED IN THESE STANDARDS. HOWEVER, THE MAXIMUM SLOPES AND MINIMUM OFFSETS DIMENSIONED FROM THE POSTS SHOWN HEREIN SHALL STILL APPLY.
3. END TREATMENT TEST LEVEL AND TYPE (TANGENT OR FLARED) SHALL BE SPECIFIED IN THE PLANS.
4. CONSTRUCT TANGENT AND FLARED END TREATMENTS IN ACCORDANCE WITH THE MANUFACTURER'S UNIQUE DRAWING DETAILS, PROCEDURES, AND SPECIFICATIONS.
5. AT THE DISCRETION OF THE ENGINEER, THE FACE OF THE TANGENT END TREATMENT IMPACT HEAD MAY BE OFFSET UP TO 2'-0" FROM THE PROJECTED FACE OF GUARDRAIL TO MINIMIZE NUISANCE HITS. THE OFFSET SHALL OCCUR OVER THE ENTIRE LENGTH OF THE END TREATMENT UNLESS OTHERWISE SPECIFIED BY THE MANUFACTURER.
6. LATERAL OFFSET OF FLARED END TREATMENT SHALL BE DETERMINED BY THE DESIGN ENGINEER FOLLOWING THE METHODOLOGY FOUND IN THE *ROADSIDE DESIGN GUIDE* AND SHOULD FALL WITHIN THE ALLOWABLE TOLERANCES SPECIFIED BY THE MANUFACTURER. LATERAL OFFSET SHALL BE MEASURED FROM THE EDGE OF TRAVELED WAY TO THE FACE OF THE GUARDRAIL AT POST #3.
7. END TREATMENTS SHALL NOT TERMINATE CURVED W-BEAM SEGMENTS.
8. END TREATMENT IMPACT HEAD DELINEATION SHALL CONFORM TO 601.63.
9. INSTALL GRADING AS SHOWN HEREIN UNDER SEPARATE PAY ITEMS.
10. SEE 400.2.2 FOR APPROACH TERMINAL GEOMETRY FOR GUARDRAIL INSTALLED ADJACENT TO CURB AND DOUBLE FACED GUARDRAIL.
11. MAINTAIN 2'-0" (MIN) OFFSET TO FRONT SLOPE BREAK DOWNSTREAM OF MIDSPAN SPLICE LOCATION AT ALL TIMES. IF, DOWNSTREAM OF THE SPLICE, GRADING CONSTRAINTS INHIBIT THIS MINIMUM OFFSET THEN USE DEEP STEEL POSTS AND TRANSITION TO A SLOPE BREAK CONDITION DESIGN PER THE DETAIL IN 400.1.5 UNTIL THE 2'-0" OFFSET CAN BE MET.

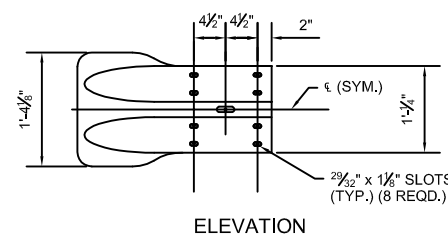




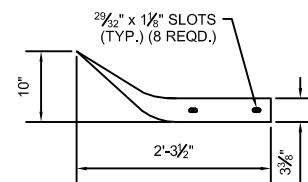
**APPROACH TO RIGID BARRIER OR BRIDGE RAIL - PLAN VIEW**  
**MEDIAN OR OUTSIDE SHOULDERS**  
**(MIRROR HORIZ. AND/OR VERT. FOR OPPOSITE**  
**DIRECTION AND/OR SIDE OF ROAD)**



**APPROACH TO RIGID BARRIER OR BRIDGE RAIL - PLAN VIEW**  
**TAPERED GUARDRAIL FOR MEDIAN**  
**(MIRROR HORIZ. AND VERT. FOR OPPOSITE DIRECTION)**



**ELEVATION**

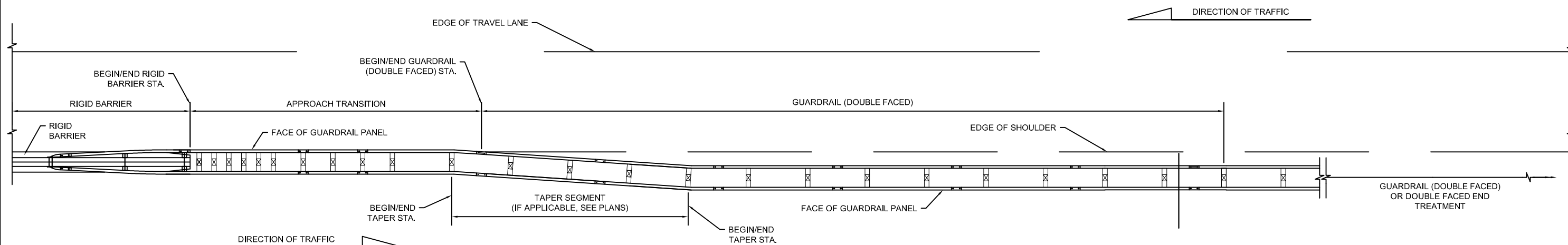


**PLAN**

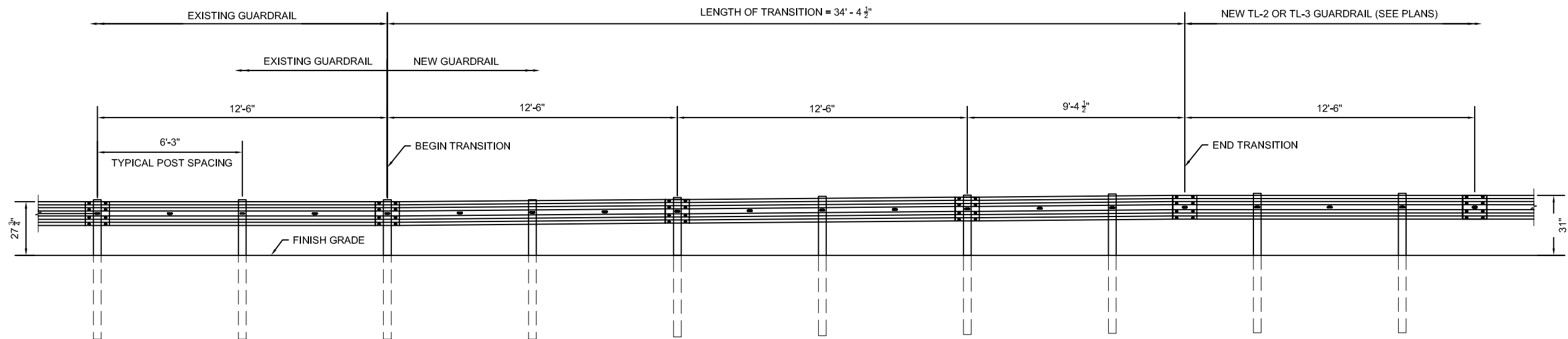
**FLARED END UNIT**

**NOTES:**

INSTALLATION: THE PLAN VIEWS SHOWN ARE SCHEMATIC ONLY, SHOWING EXAMPLE GEOMETRY FOR CONNECTING GUARDRAIL SEGMENTS INCLUDING TAPER LOCATIONS AND DOUBLE FACED GUARDRAIL REQUIREMENTS AS APPLICABLE. WORK THIS SHEET WITH THE PLANS, WHERE STATIONING AND OFFSETS FOR BEG/END GUARDRAIL, BEG/END RIGID BARRIER, AND BEG/END TAPER ARE SPECIFIED.

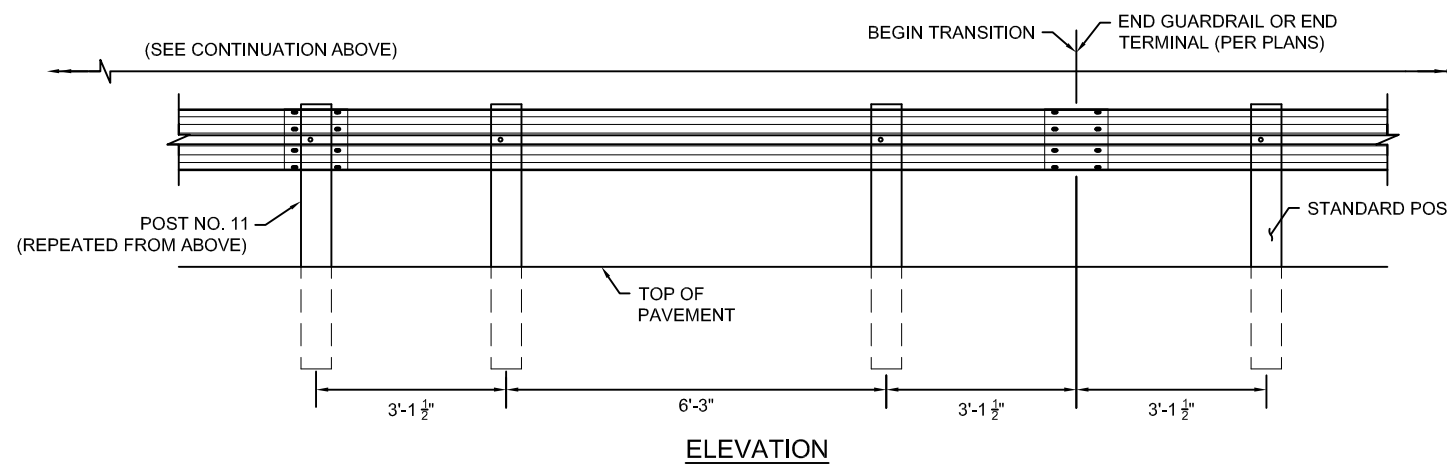
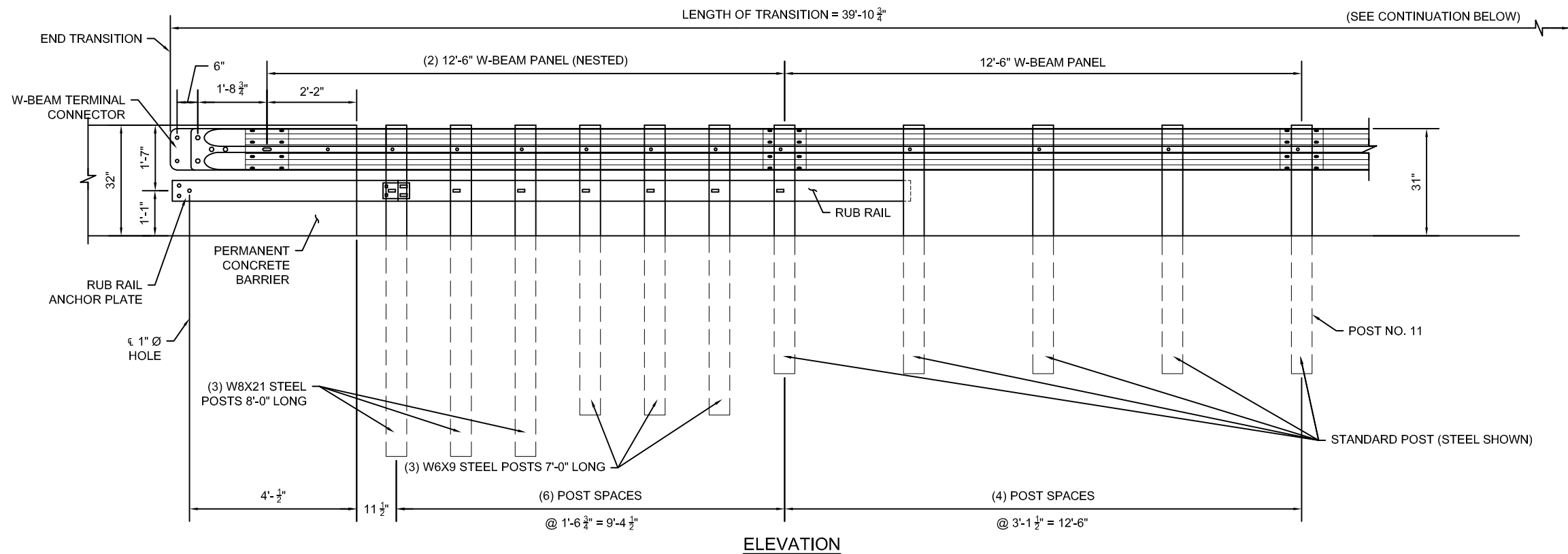
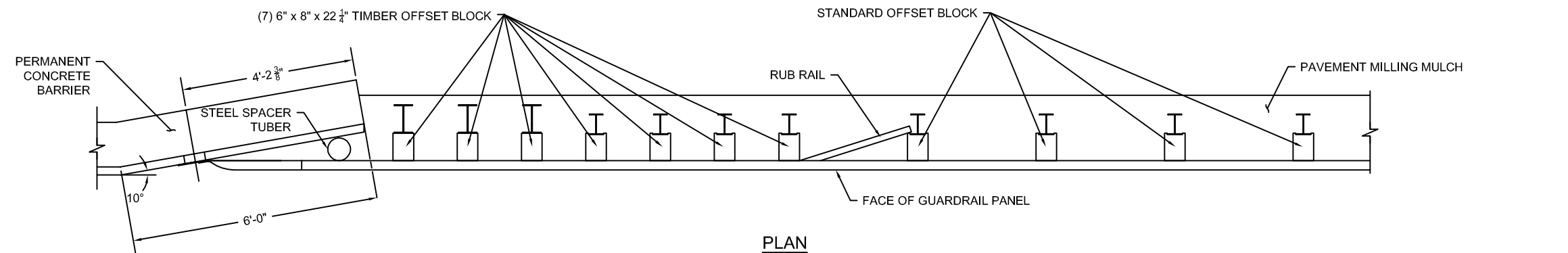


APPROACH TO RIGID BARRIER - DOUBLE FACED GUARDRAIL  
PLAN VIEW - MEDIAN SHOULDERS ONLY  
(MIRROR HORIZ. AND VERT. FOR OPPOSITE DIRECTION)



**NOTES:**

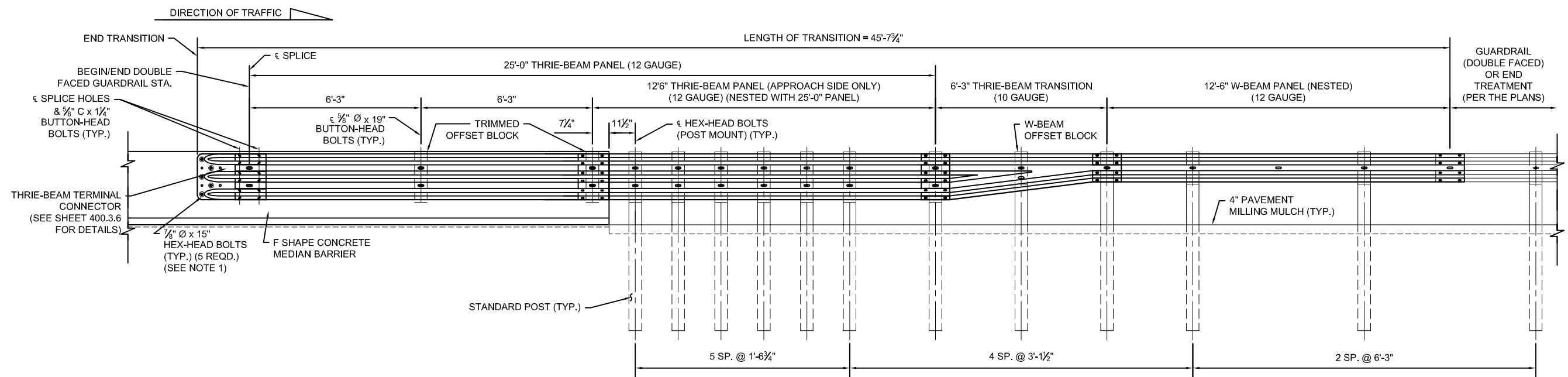
1. MAINTAIN STANDARD 1" CLEARANCE OF POST ABOVE PANEL THROUGHOUT THE ENTIRE LENGTH OF TRANSITION.
2. A MINIMUM OF ONE (1) 12'-6" PANEL SHALL BE PLACED BETWEEN THIS TRANSITION AND THE START OF ANY END TREATMENT OR ANCHORAGE.
3. ALL NEW POSTS SHALL BE 72" IN LENGTH UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.
4. ALL NEW POSTS AND OFFSET BLOCK MATERIALS SHALL MATCH EXISTING UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.



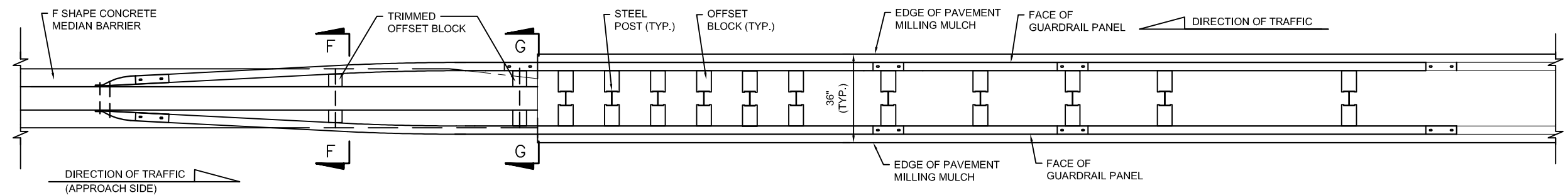
#### NOTES:

1. SEE SHEET 400.3.4 FOR COMPONENT DETAILS.
2. BOLT RUB RAIL TO POST WITHOUT WASHER.
3. POSTS WITH RUB RAIL ATTACHMENT REQUIRE AN ADDITIONAL HOLE.
4. STEEL SPACER TUBE, SCHEDULE 40 GALVANIZED PIPE, 6" ID X 12". CONNECT TO THE W-BEAM PANEL ELEMENTS USING SPLICE BOLT.

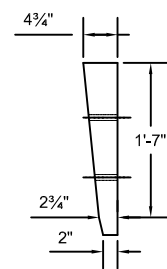




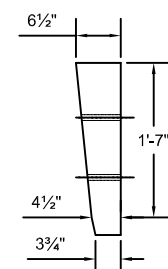
ELEVATION (APPROACH SIDE)



PLAN

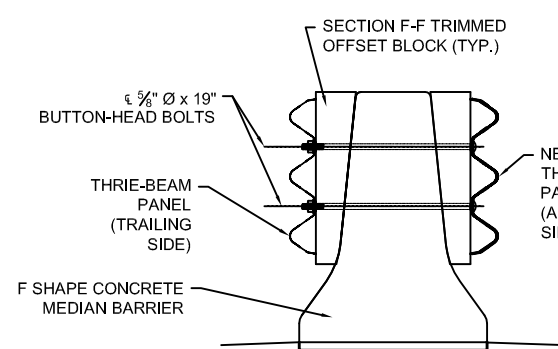


SECTION F-F

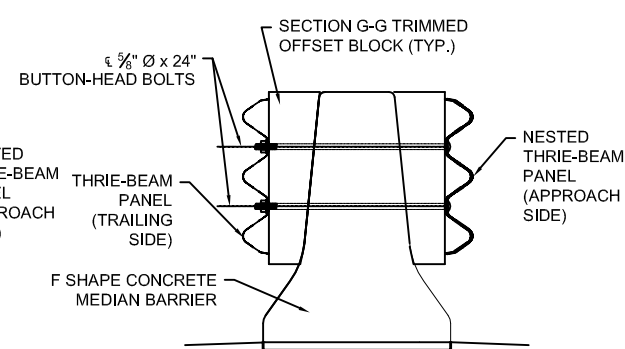


SECTION G-G

TRIMMED OFFSET BLOCKS  
(TIMBER ONLY)



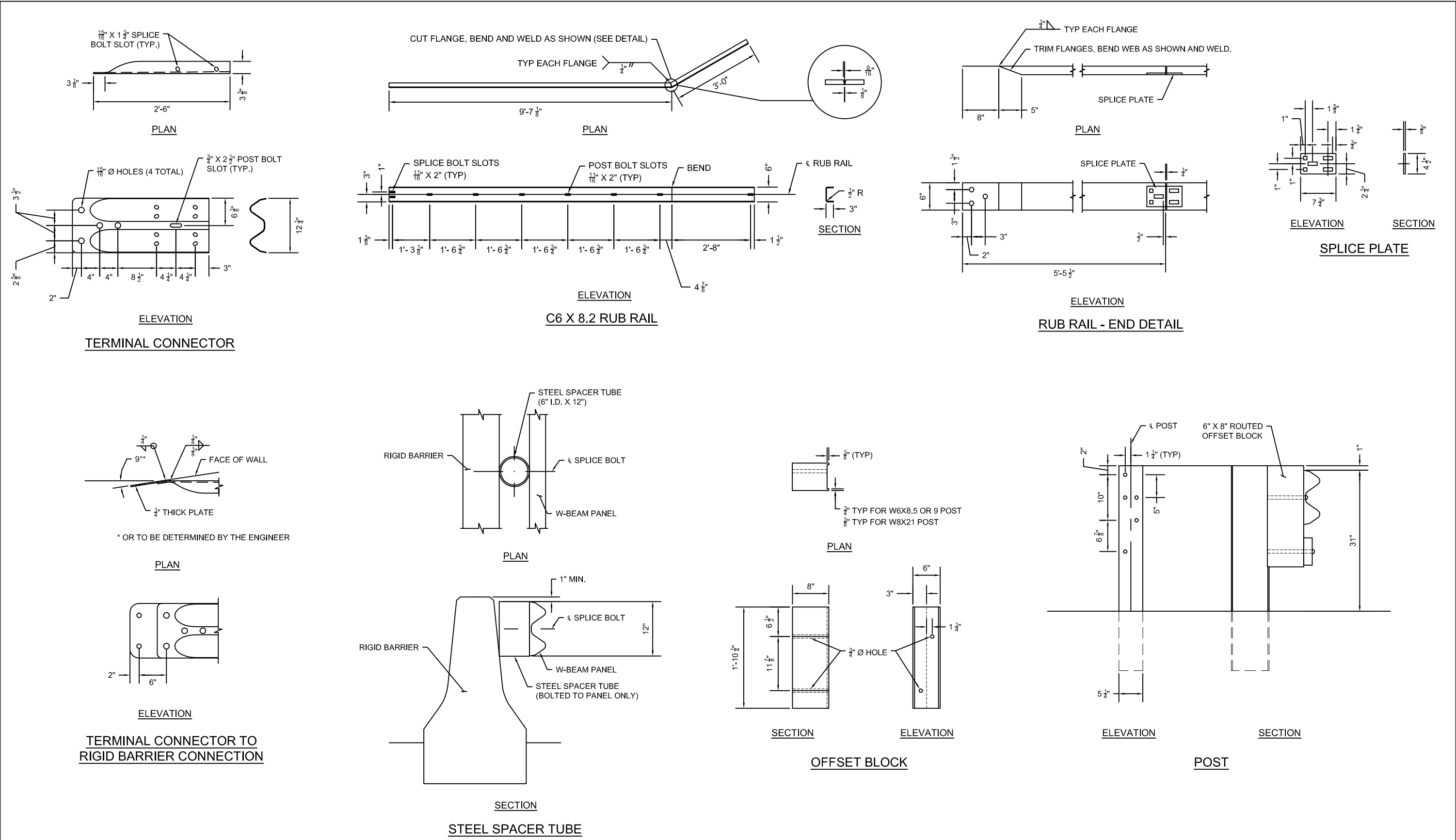
SECTION F-F

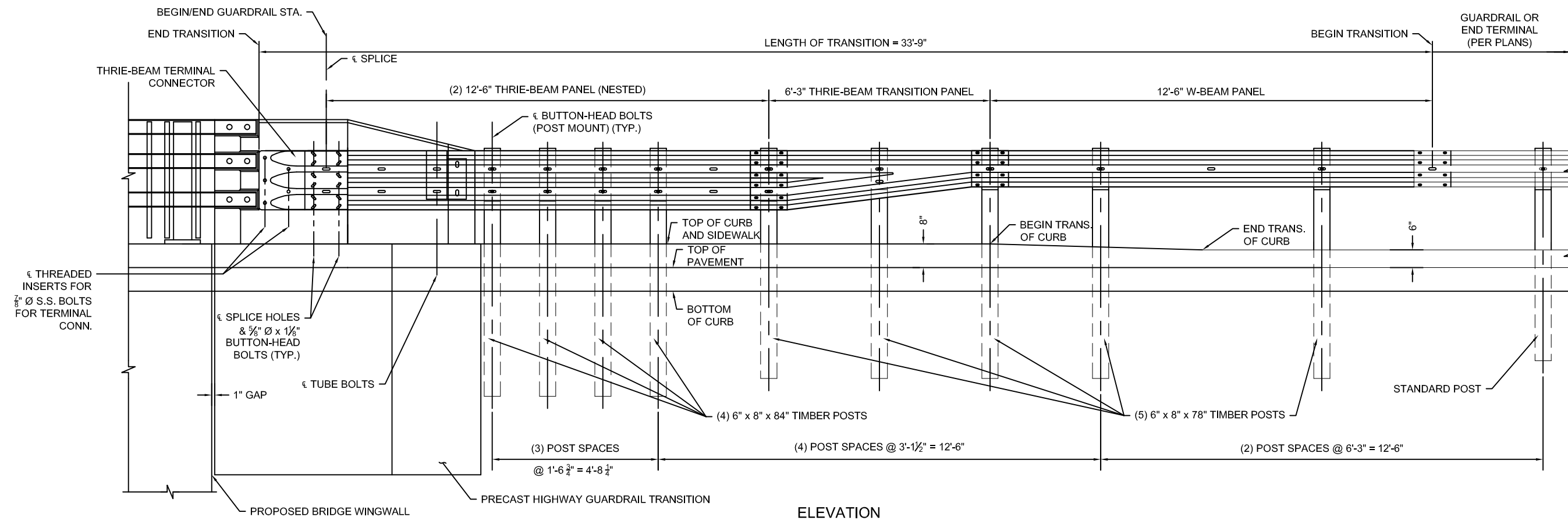
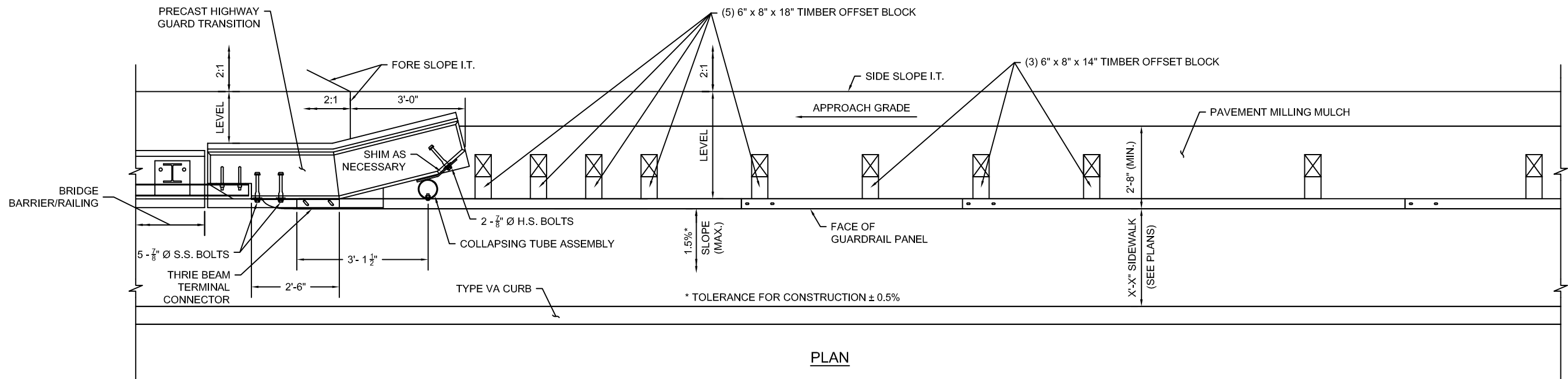


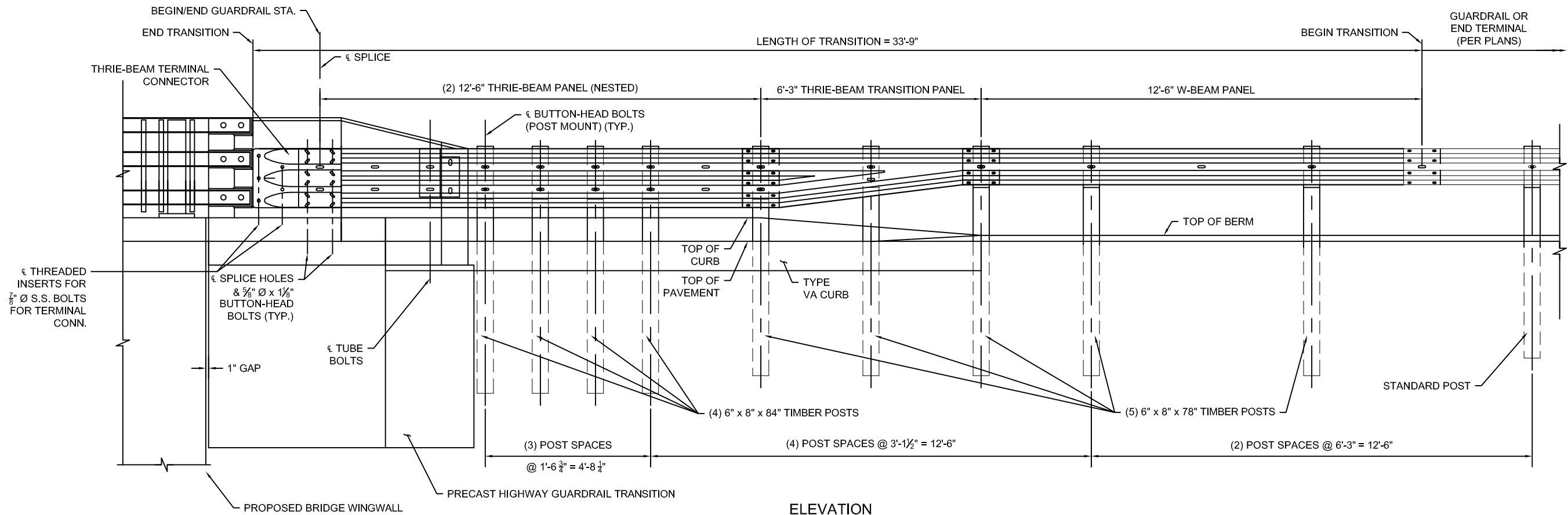
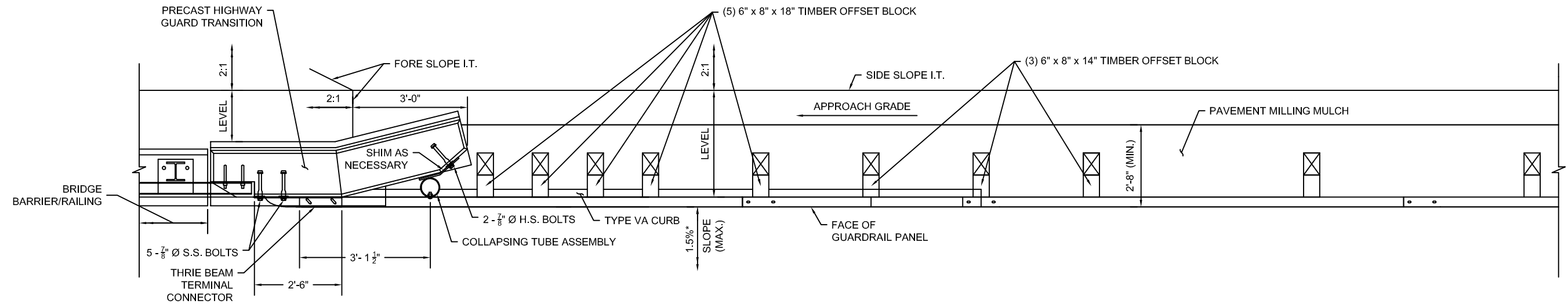
SECTION G-G

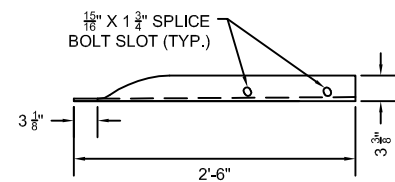
NOTES:

1. SEE SHEET 400.3.4 FOR CONSTRUCTION DETAILS OF THE THRIE-BEAM TERMINAL CONNECTOR. THE INSTALLED BOLT'S THREADED PORTION IS NOT PERMITTED TO EXTEND BEYOND 3/4" FROM THE FACE OF THE NUT; TRIM THE THREADED PORTION AS NEEDED AND GALVANIZE IN ACCORDANCE WITH M8.07.0.

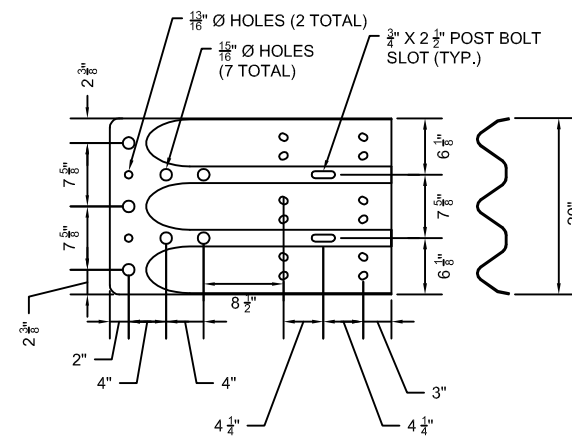






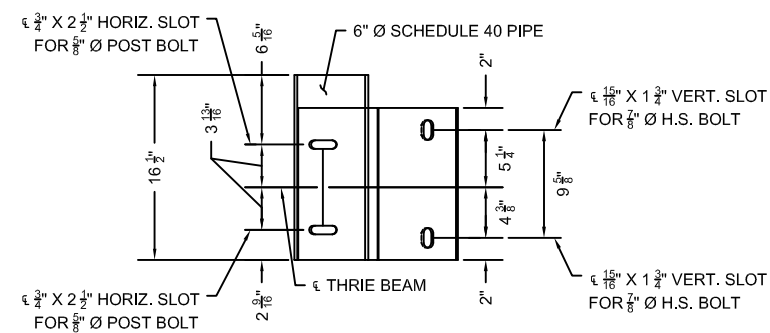


PLAN

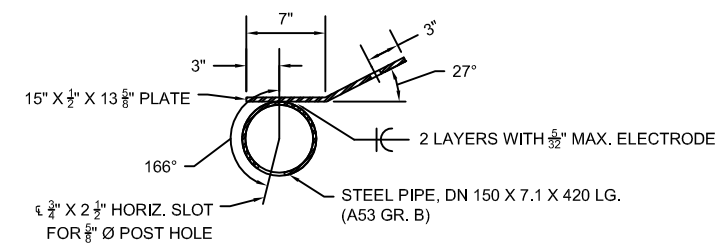


ELEVATION

TERMINAL CONNECTOR

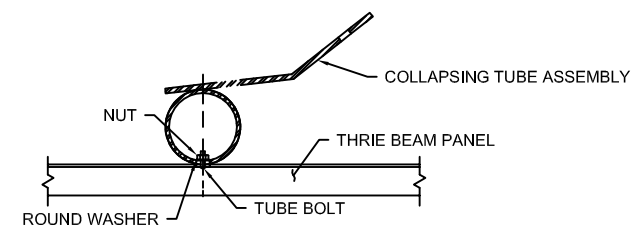


ELEVATION



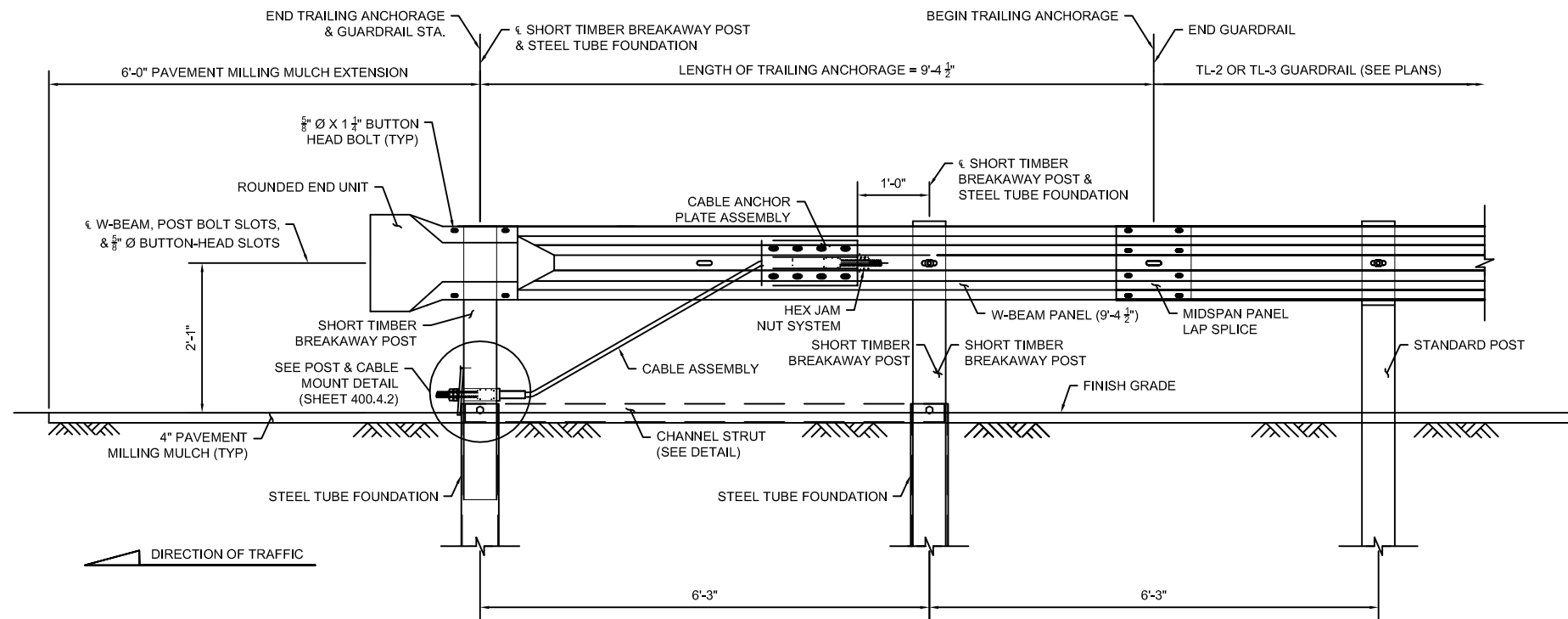
PLAN

COLLAPSING TUBE ASSEMBLY

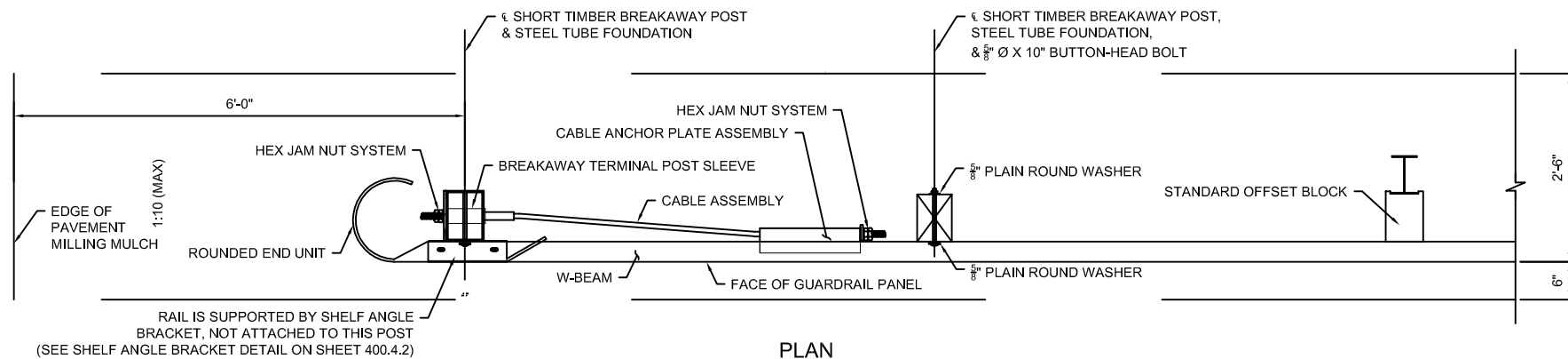


PLAN

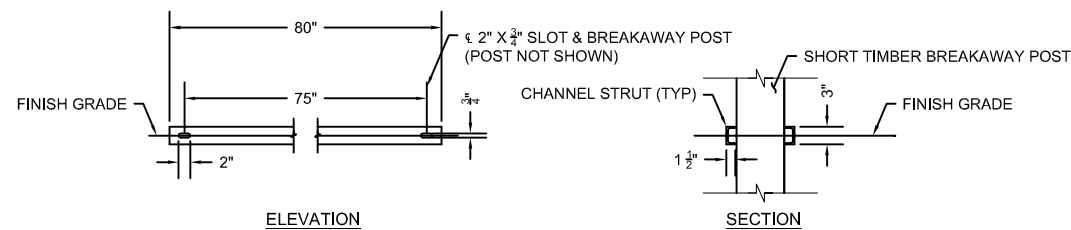
RAIL/TUBE CONNECTION



**ELEVATION**



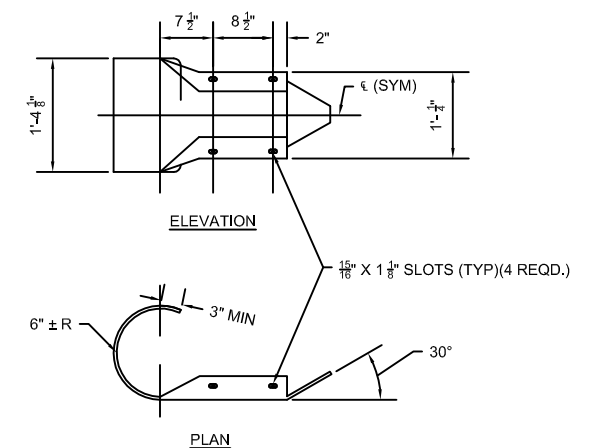
**PLAN**



**ELEVATION**

**SECTION**

**CHANNEL STRUT**



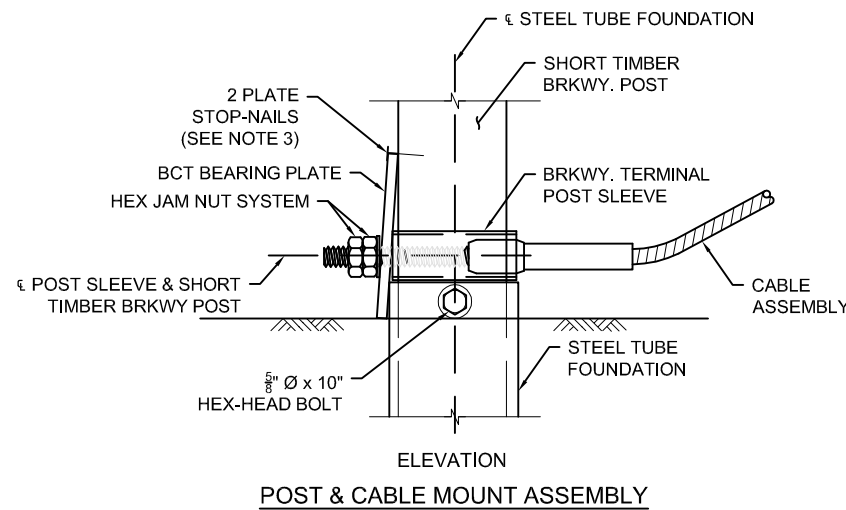
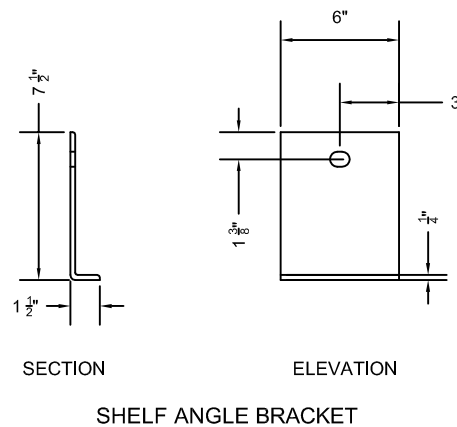
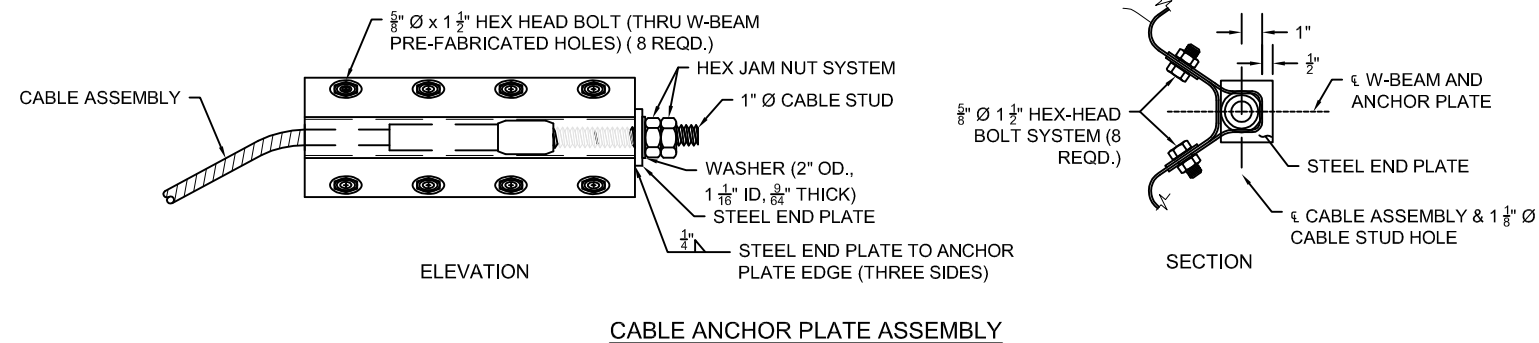
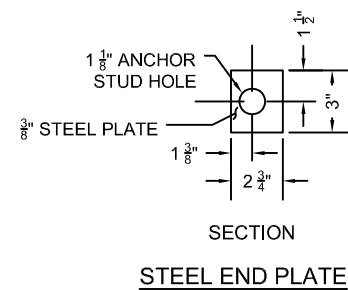
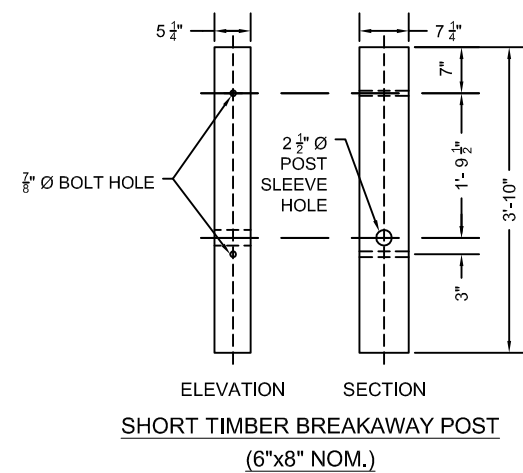
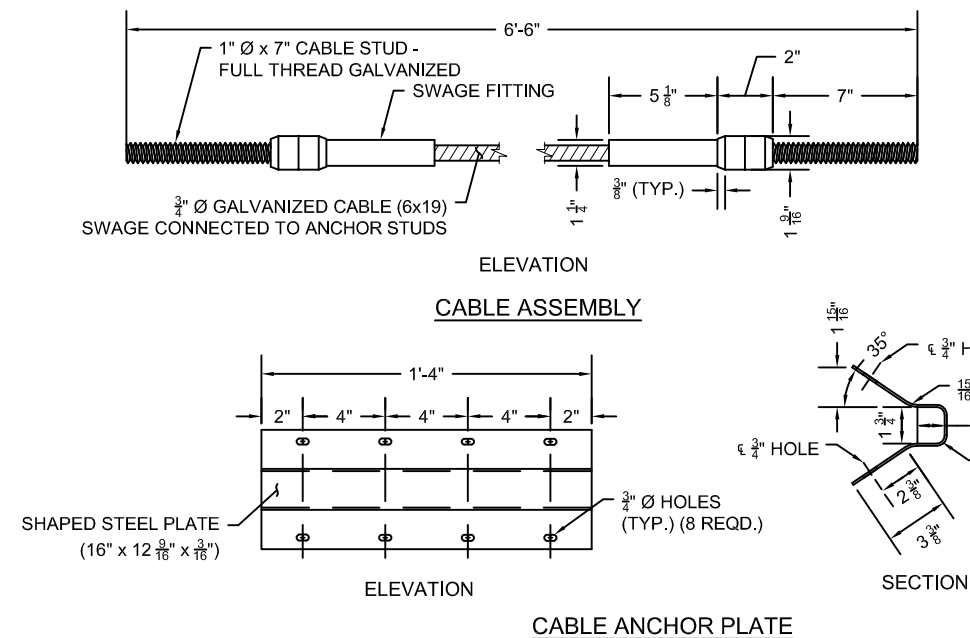
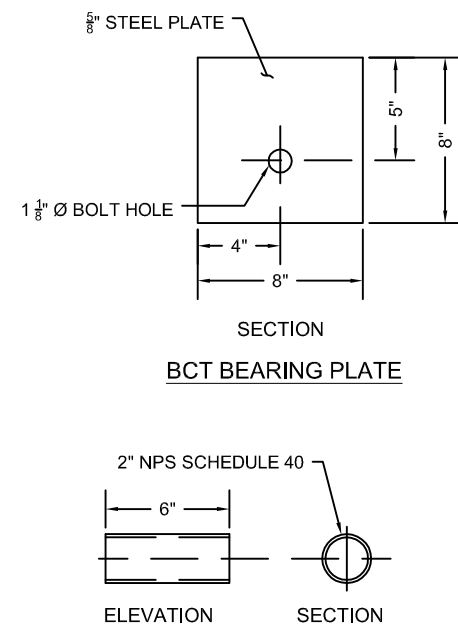
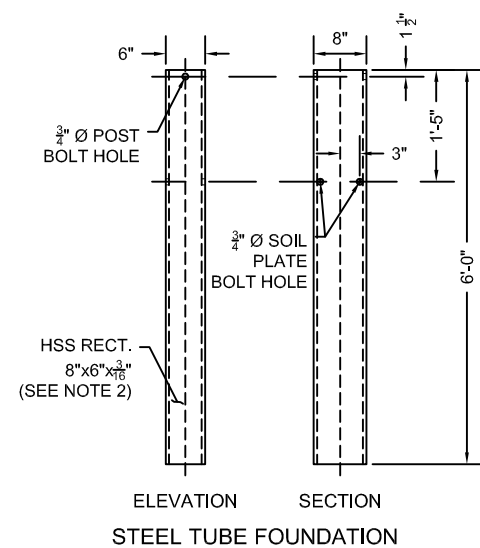
**ELEVATION**

**PLAN**

**ROUNDED END UNIT**

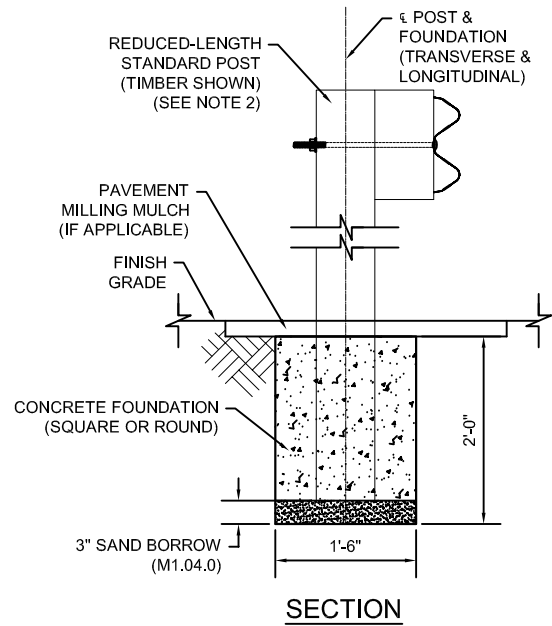
**NOTES:**

1. FOR ADDITIONAL DETAILS, SEE 400.4.2.
2. LAP THE ROUNDED END UNIT OVER THE FACE OF THE W-BEAM PANEL.
3. INSTALL STEEL TUBE FOUNDATIONS BY ONE OF THE FOLLOWING METHODS:
  - A. EXCAVATE, INSTALL TUBE, BACKFILL, AND SUITABLY COMPACT MATERIALS; OR
  - B. DRIVE THE TUBE USING A DUMMY TIMBER POST TO PREVENT DAMAGE TO THE SHORT BREAKAWAY POST.



#### NOTES:

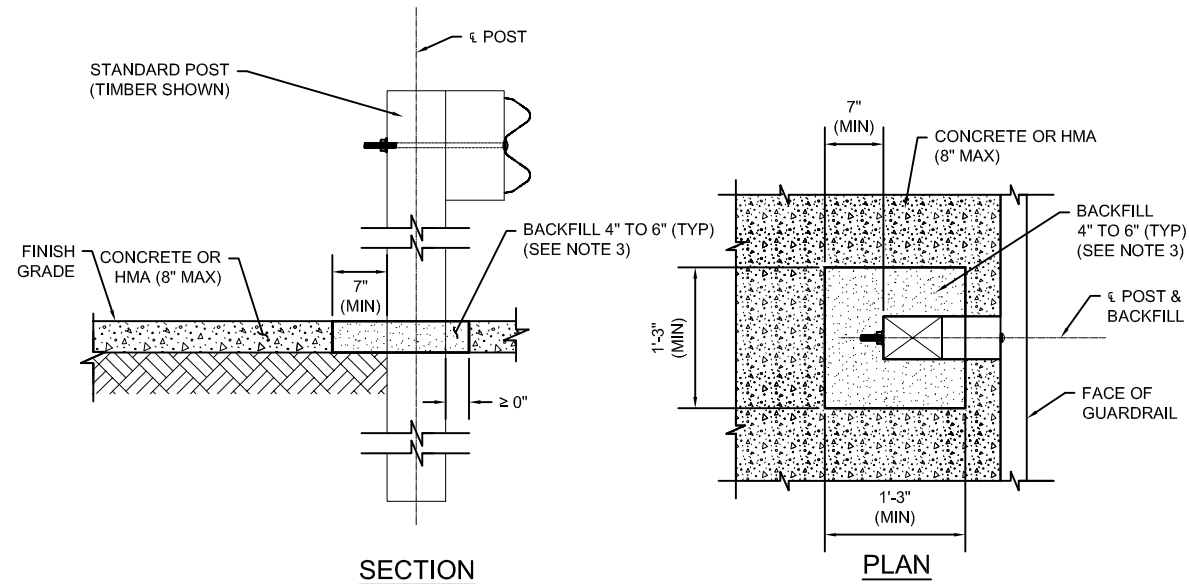
- COMPONENTS SHALL BE INSTALLED PER 400.4.1.
- HEX NUTS, HEX JAM NUTS AND WASHERS SHALL BE IN ACCORDANCE WITH AASHTO-ARTBA-AGC A GUIDE TO STANDARDIZING HIGHWAY BARRIER HARDWARE. TWO HEX NUTS MAY BE USED FOR THE HEX JAM SYSTEM.
- DRIVE TWO ASTM A153 HOT DIP GALVANIZED STEEL 2 1/2" TYPE 8D NAILS TO PREVENT ROTATION OF THE BCT BEARING PLATE.



#### NOTES:

1. WHEN THE CONSTRUCTION OF GUARDRAIL AT THE REQUIRED POST SPACING RESULTS IN POST(S) CONFLICTING WITH UNDERGROUND UTILITIES OR OTHER UNDERGROUND OBSTRUCTIONS, AN ENCASED POST MAY BE USED WHERE A 2'-0" DEPTH WILL AVOID THE CONFLICT. INSTALL WHERE SHOWN IN THE PLANS AND/OR AS-NEEDED.
2. USE A STANDARD POST WITH REDUCED LENGTH SUCH THAT THE PANEL HEIGHT IS MAINTAINED WHILE THE POST BOTTOM TERMINATES AT THE BOTTOM OF THE CONCRETE FOUNDATION AT THE TOP OF THE 3" (MIN) SAND BORROW.
3. CONCRETE FOUNDATION SHALL BE 3500 PSI, CEMENT CONCRETE (M4.02.00). AFTER CASTING THE CONCRETE, ENSURE THE SURROUNDING SOIL MATERIAL IS COMPLETELY BACKFILLED AND TAMPED TO PROVIDE FULL PASSIVE RESISTANCE.
4. ENCASED POSTS ARE NOT PERMITTED FOR CONSECUTIVE POSTS UNLESS OTHERWISE SHOWN IN THE PLANS.

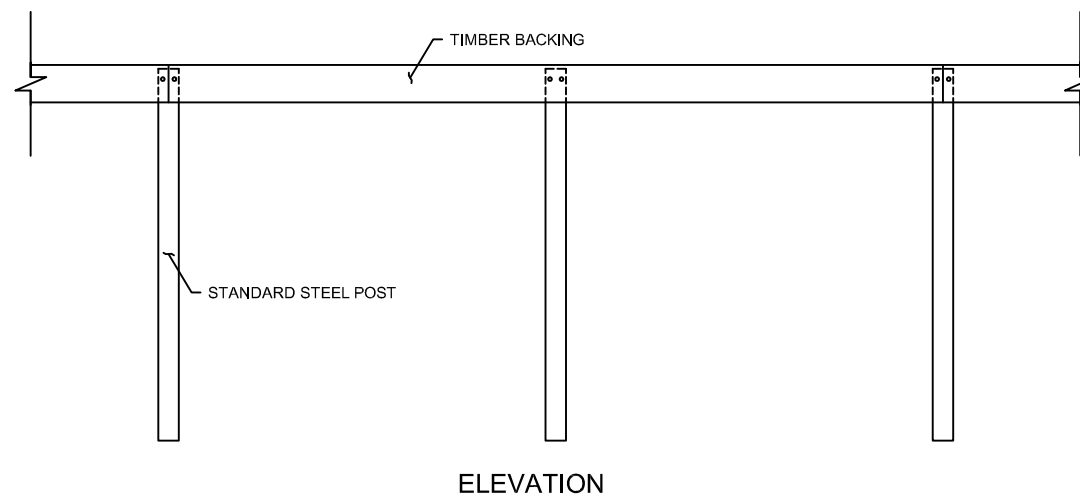
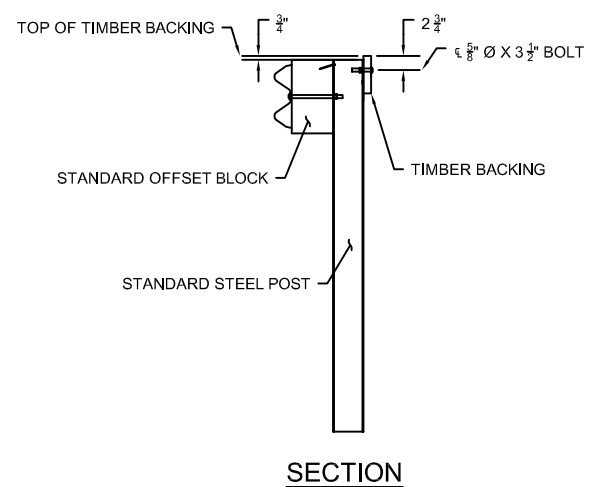
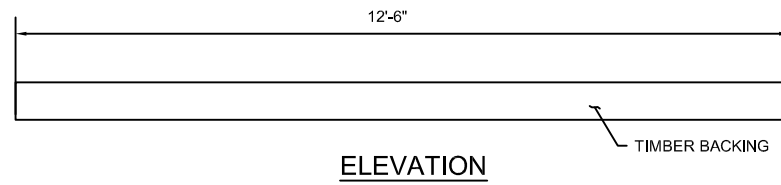
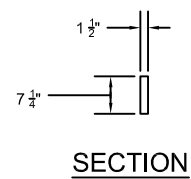
ENCASED POST FOR SHALLOW MOUNT



#### NOTES:

1. WHEN THE CONSTRUCTION OF GUARDRAIL AT THE REQUIRED POST SPACING RESULTS IN POST(S) PLACED WITHIN A CONCRETE OR HMA SURFACE, USE A FRANGIBLE LEAVE-OUT AROUND THE POST BASE AS SHOWN. INSTALL WHERE SHOWN IN THE PLANS AND/OR AS NEEDED.
2. FOR THE REQUIRED 1'-6" x 1'-6" LEAVE-OUT, SMOOTHLY CUT THE EXISTING CONCRETE OR HMA SURFACE OR FORM-UP THE SQUARE SHAPE WHEN AN APPLICATION HAS NEW SURROUNDING CONCRETE.
3. USE AN EXCAVATABLE CONTROLLED DENSITY FILL (M4.08.0 TYPE 1E OR 2E) OR COMPACTED GRAVEL BORROW (M1.03.0 TYPE C) FOR BACKFILL.
4. ENSURE FILL MATERIAL SURFACE IS SMOOTH AND EVEN WITH THE ADJACENT SURFACE.

FRANGIBLE LEAVE-OUT FOR CONCRETE OR HMA SURFACE

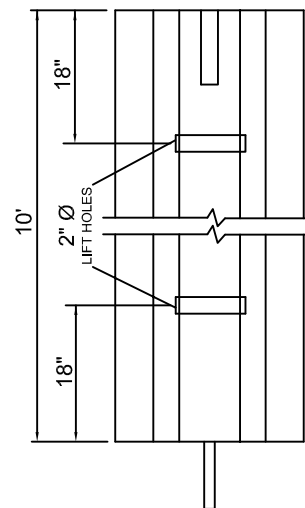
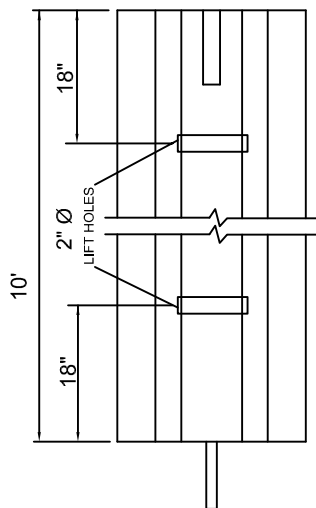
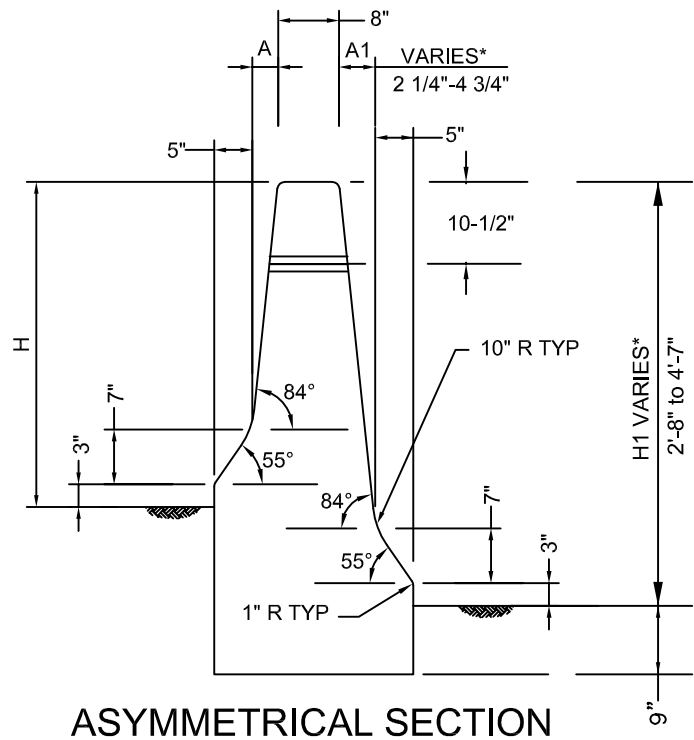
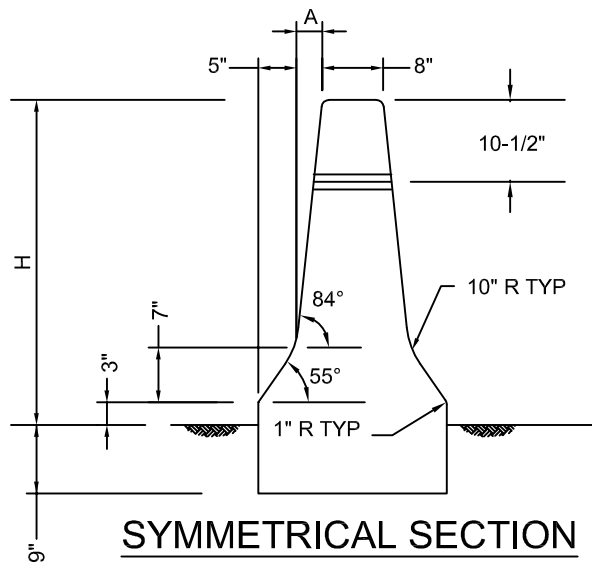


#### NOTES:

1. TIMBER BACKING SHALL CONFORM TO M9.05.3.
2. BACKING SHALL NOT BE INSTALLED WITHIN 50 FEET OF AN END TERMINAL

TIMBER BACKING FOR STEEL POSTS ADJACENT TO MULTI-USE PATHS



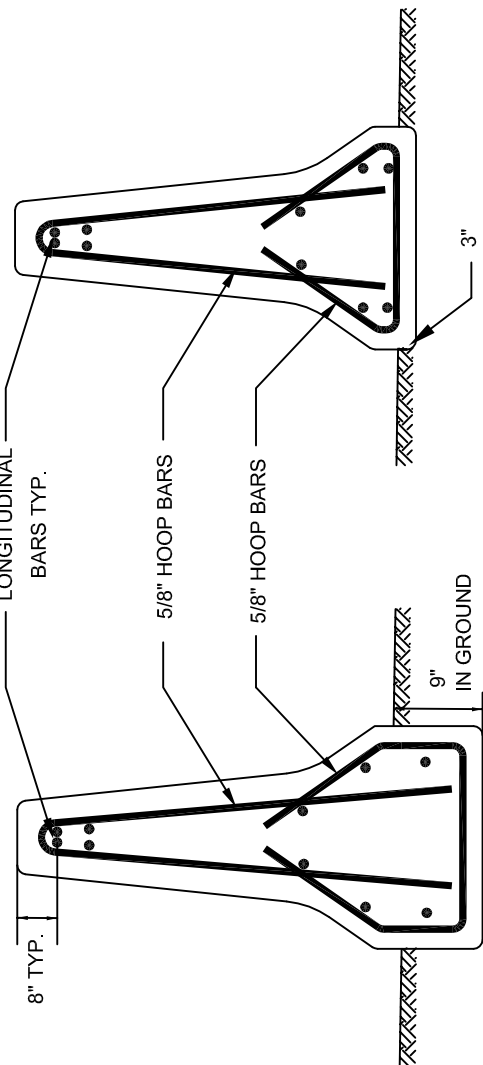
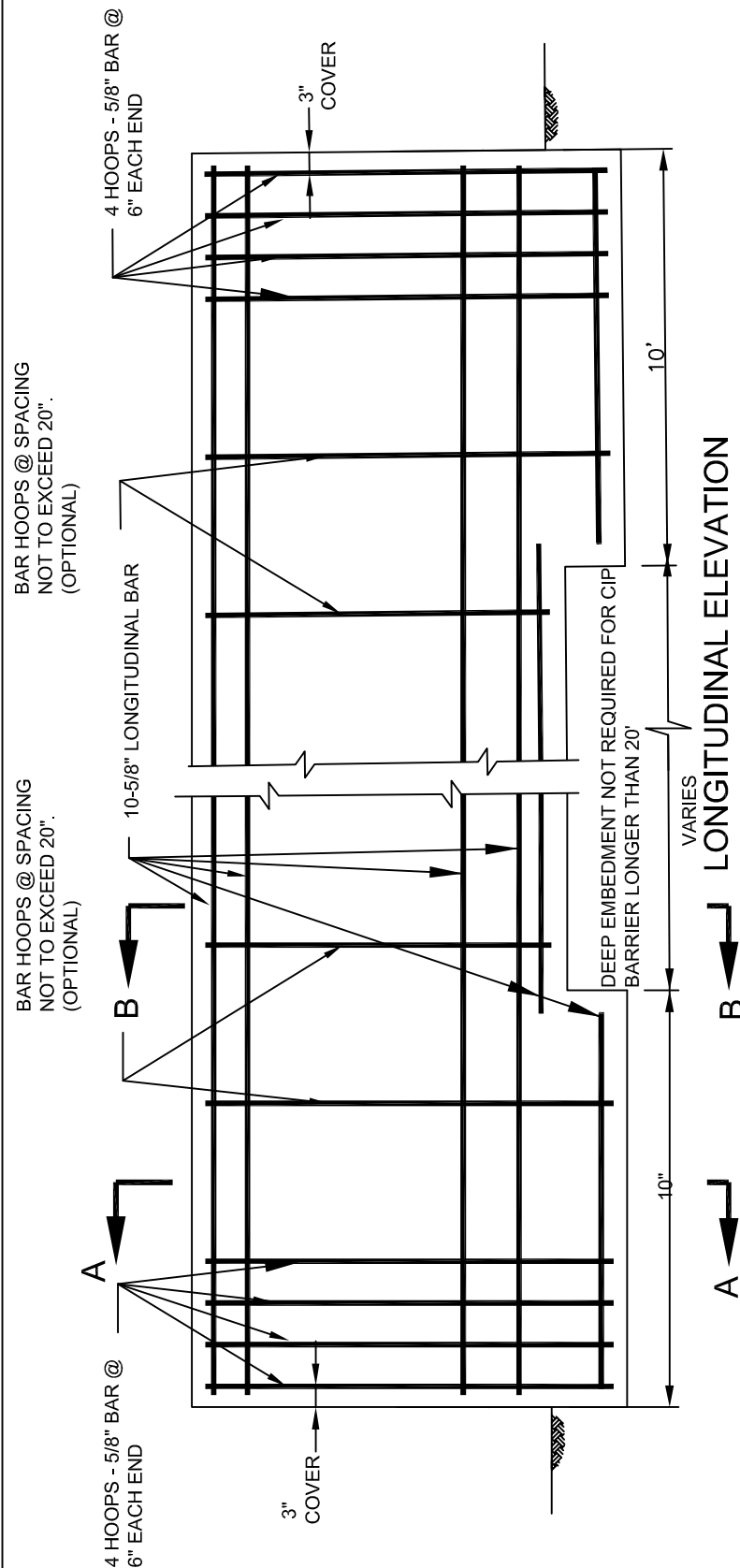


SYSTEM	A	H
NORMAL	2 1/4"	2'-8"
TALL	3 1/4"	3'-6"

NOTES:

1. ALL EDGES SHALL BE ROUNDED WITH A 1" RADIUS EXCEPT AS SHOWN
  2. FOR DOWEL CONNECTION DETAILS SEE E 402.13.0.
  3. FOR REINFORCING SEE E 402.11.0 FOR SYMMETRICAL SHAPE AND E 401.12.0 FOR ASYMMETRICAL SHAPE.
  4. ALL CONCRETE IS TO BE FIELD COATED AFTER FINAL INSTALLATION WITH A CONCRETE PENETRANT/SEALER. CAST IN PLACE CONCRETE SHALL CURE NOT LESS THAN 28 DAYS PRIOR TO COATING.
  5. LIFT HOLES USED ONLY ON PRECAST BARRIERS 13' AND LESS.
- \* VARY "A1" RELATIVE TO "H1" WHILE MAINTAINING 55° AND 84° BARRIER ANGLES.  
A1=4-3/4" MAX., H1=4'-7" MAX.

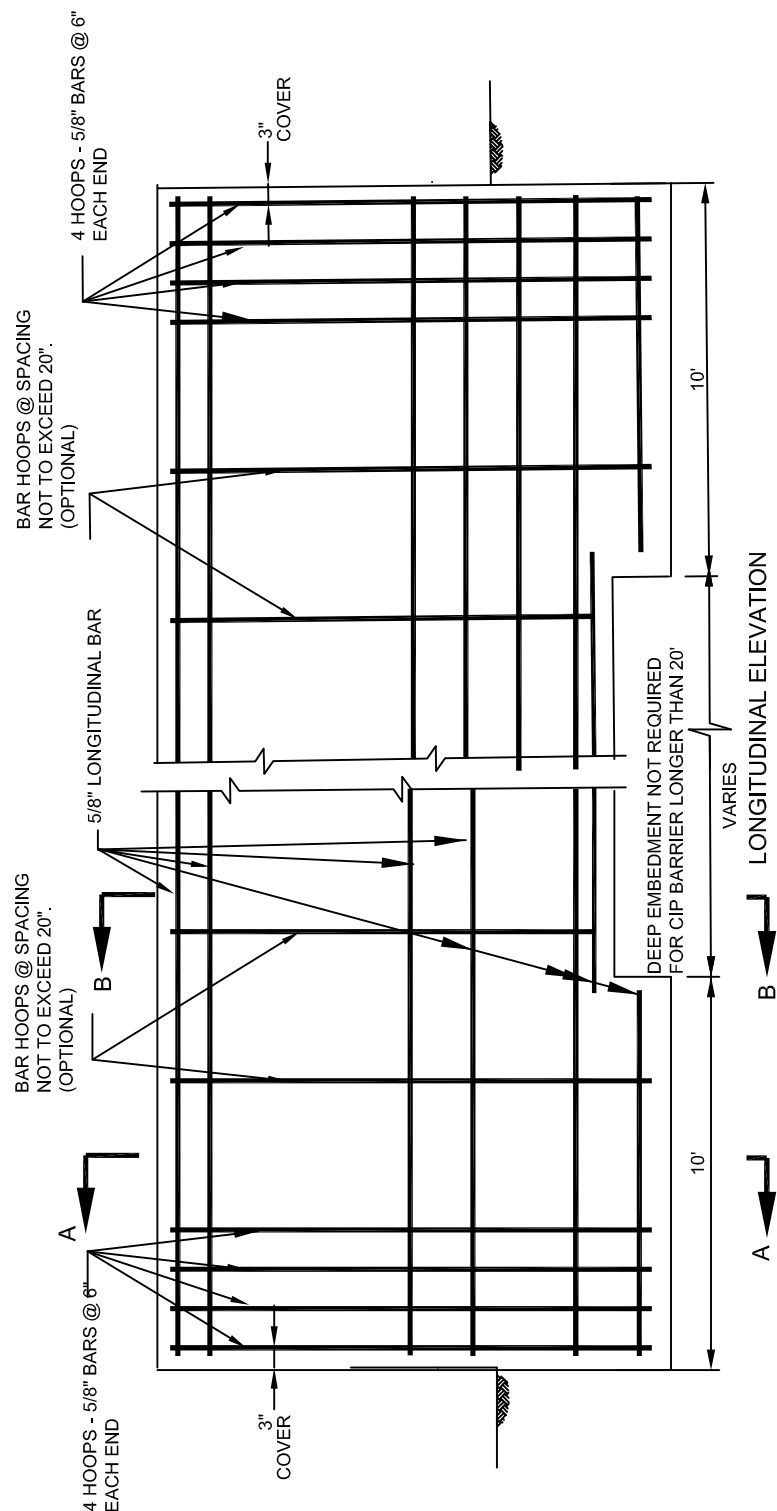
# F SHAPE CONCRETE BARRIER SYMMETRICAL SECTION REINFORCING DETAILS



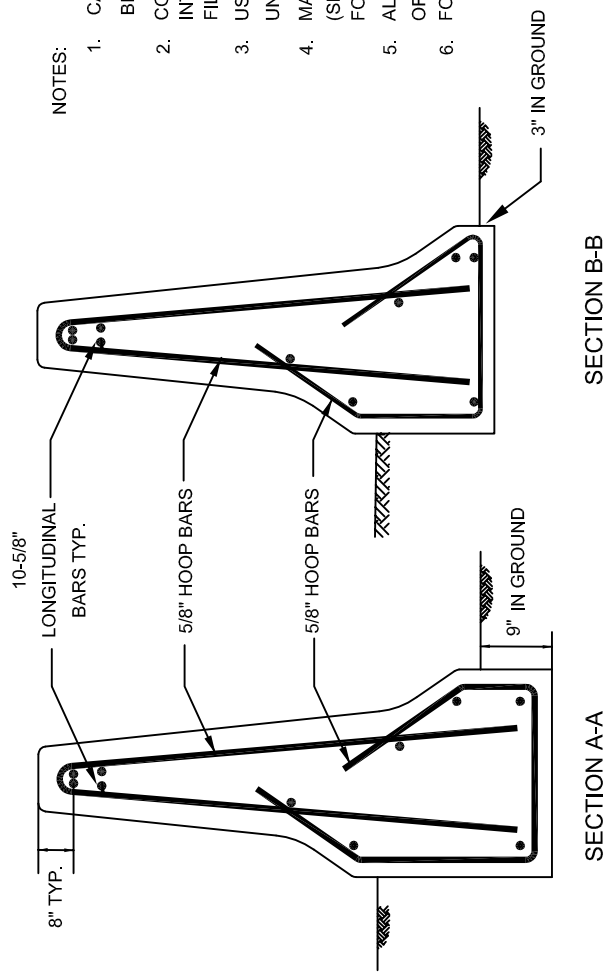
## NOTES:

1. CAST IN PLACE NOT TO EXCEED 200' BETWEEN EXPANSION JOINTS.
2. CONSTRUCTION JOINTS REQUIRED AT 40' INTERVALS (1/2" PREMOULDED JOINT FILLER REQUIRED FOR PRECAST BARRIERS).
3. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
4. MATERIAL IS 4000 PSI CEMENT CONCRETE. (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
5. ALL STEEL REINFORCING TO BE GALVANIZED OR EPOXY COATED, AASHTO-M31, GRADE 60.
6. ALL LONGITUDINAL BARS ARE TO BE CONTINUOUS FOR BOTH PRECAST AND CAST IN PLACE BARRIERS.
7. FOR DIMENSIONS SEE E 402.10.0

# F SHAPE CONCRETE BARRIER ASYMMETRICAL SECTION REINFORCING DETAILS

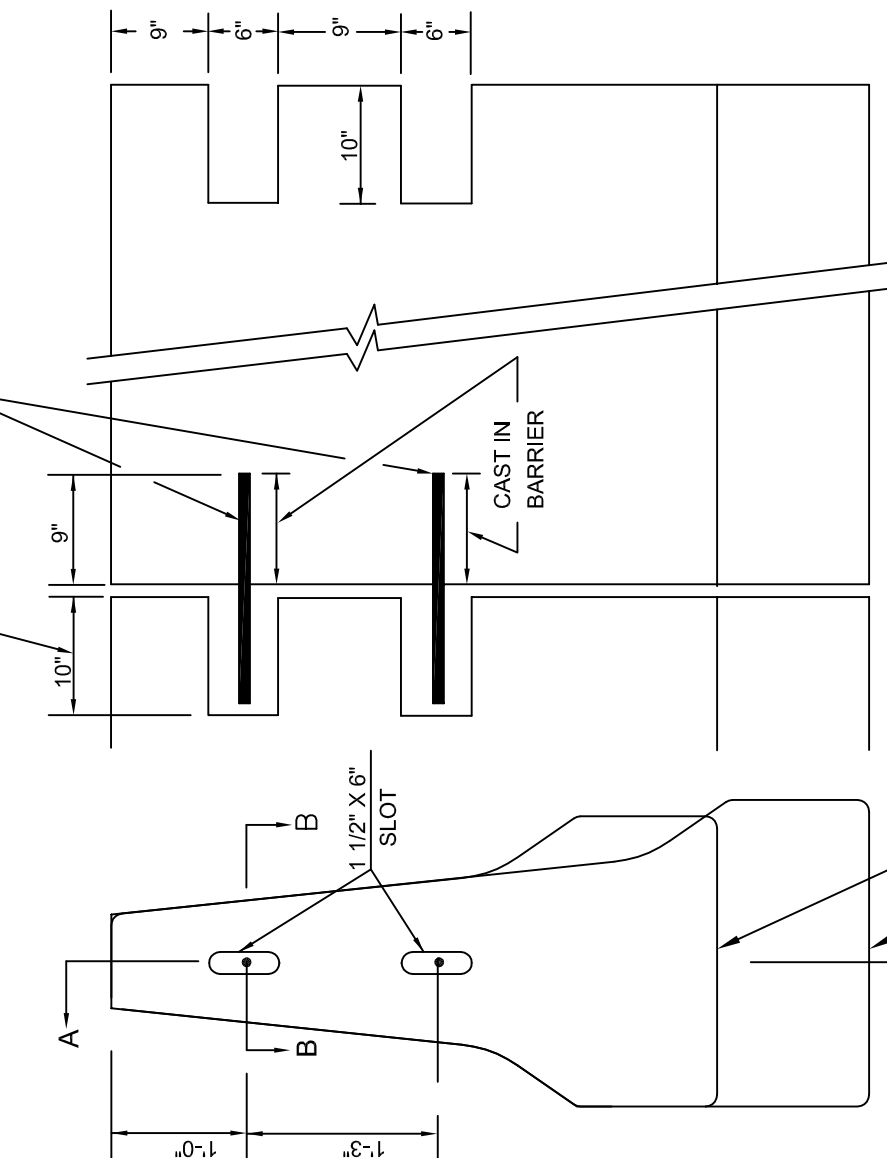


- NOTES:
1. CAST IN PLACE NOT TO EXCEED 200' BETWEEN EXPANSION JOINTS.
  2. CONSTRUCTION JOINTS REQUIRED AT 40' INTERVALS (1/2" PREMOULDED JOINT FILLER REQUIRED FOR PRECAST BARRIERS).
  3. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
  4. MATERIAL IS 4000 PSI CEMENT CONCRETE. (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
  5. ALL STEEL REINFORCING TO BE GALVANIZED OR EPOXY COATED, AASHTO-M31, GRADE 60.
  6. FOR DIMENSIONS SEE E 402.10.0



1-1/2" X 6" SLOT 10" DEEP

1" Ø PLAIN SMOOTH BAR DOWEL  
18" LONG



SECTION B-B

SECTION A-A

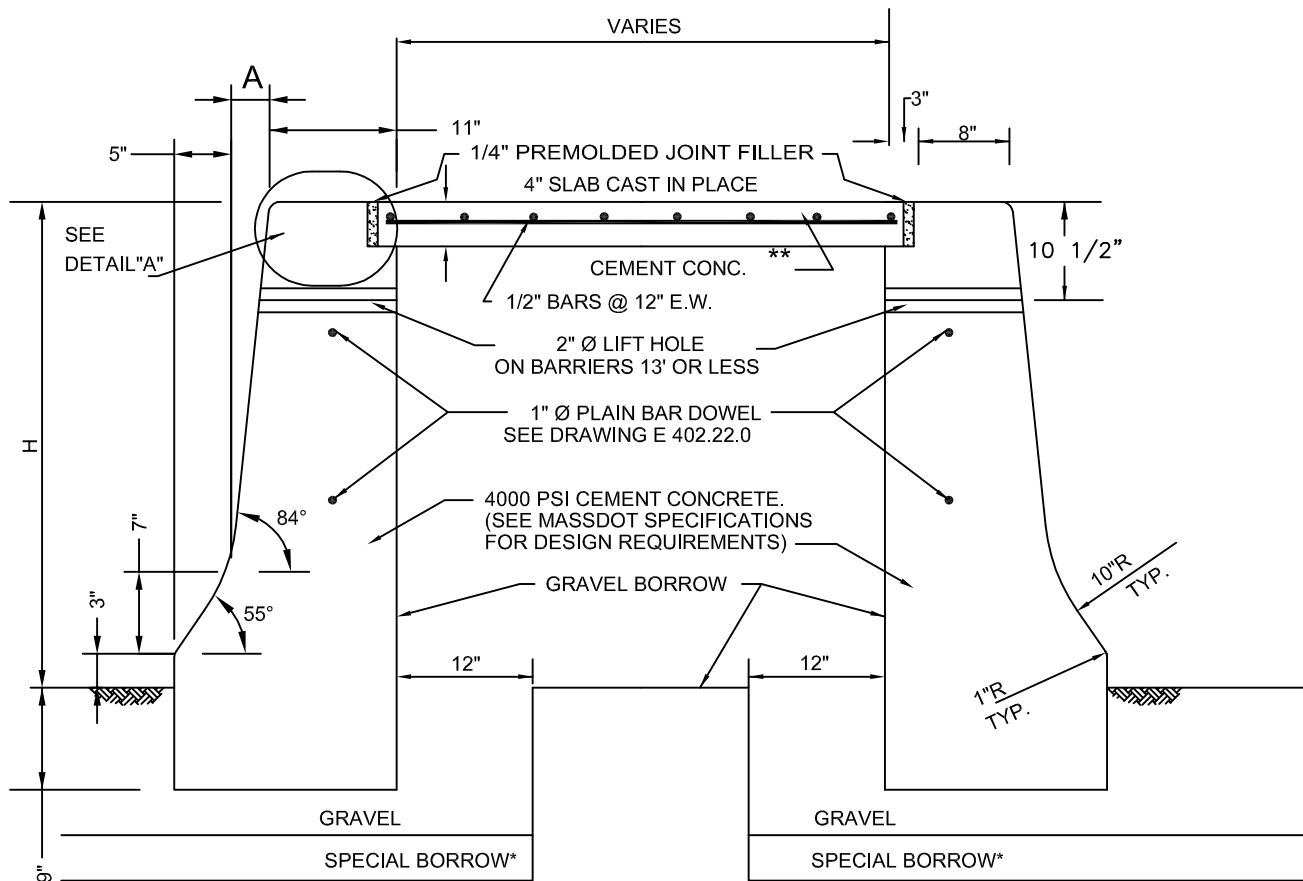
SYMMETRICAL SECTION

ASYMMETRICAL SECTION

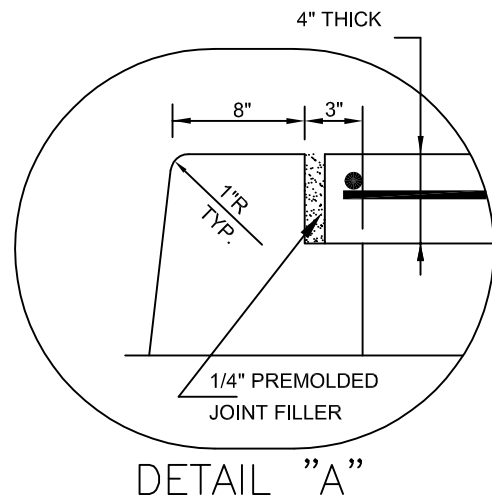
ELEVATION

NOTES:

1. DOWELS TO BE GALVANIZED, AASHTO-M31, GRADE 60.
2. FOR ADDITIONAL DETAILS SEE E 402.10.0



SYSTEM	A	H
NORMAL	2-3/8"	2'-8"
TALL	3-11/32"	3'-6 1/8"



\* SAME DEPTH AS UNDER ROADWAY.

\*\* BARRIER CAP BUILT USING 4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS).

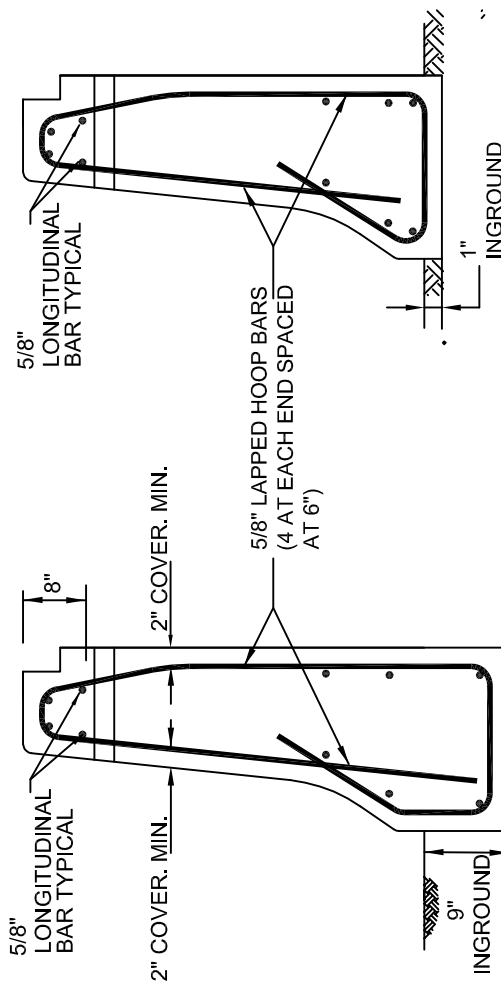
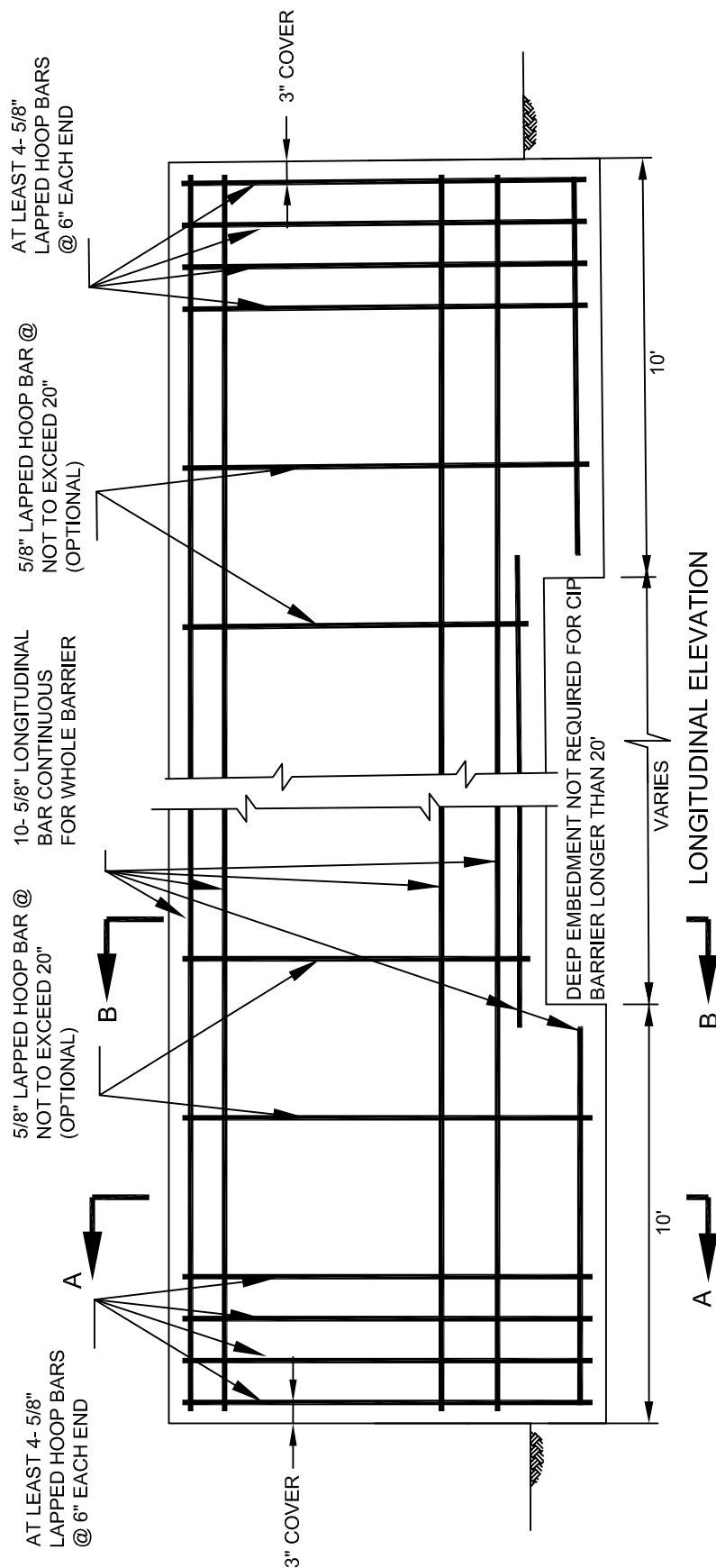
#### NOTES:

1. ALL LONGITUDINAL BARS TO BE CONTINUOUS FOR BOTH PRECAST BARRIERS AND CAST IN PLACE BARRIERS.
2. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
3. ALL CONCRETE IS TO BE FIELD COATED AFTER FINAL INSTALLATION WITH A CONCRETE PENETRANT/SEALER. CONCRETE SHALL CURE NOT LESS THAN 28 DAYS PRIOR TO COATING.
4. FOR REINFORCING DETAILS SEE E 402.21.0
5. FOR DOWEL DETAILS SEE E 402.22.0
6. TAR PAPER TO BE PLACED INSIDE LIFT HOLES AND BARRIER JOINTS.

# F SHAPE CONCRETE BARRIER WITH CONCRETE SEPARATOR REINFORCING DETAILS

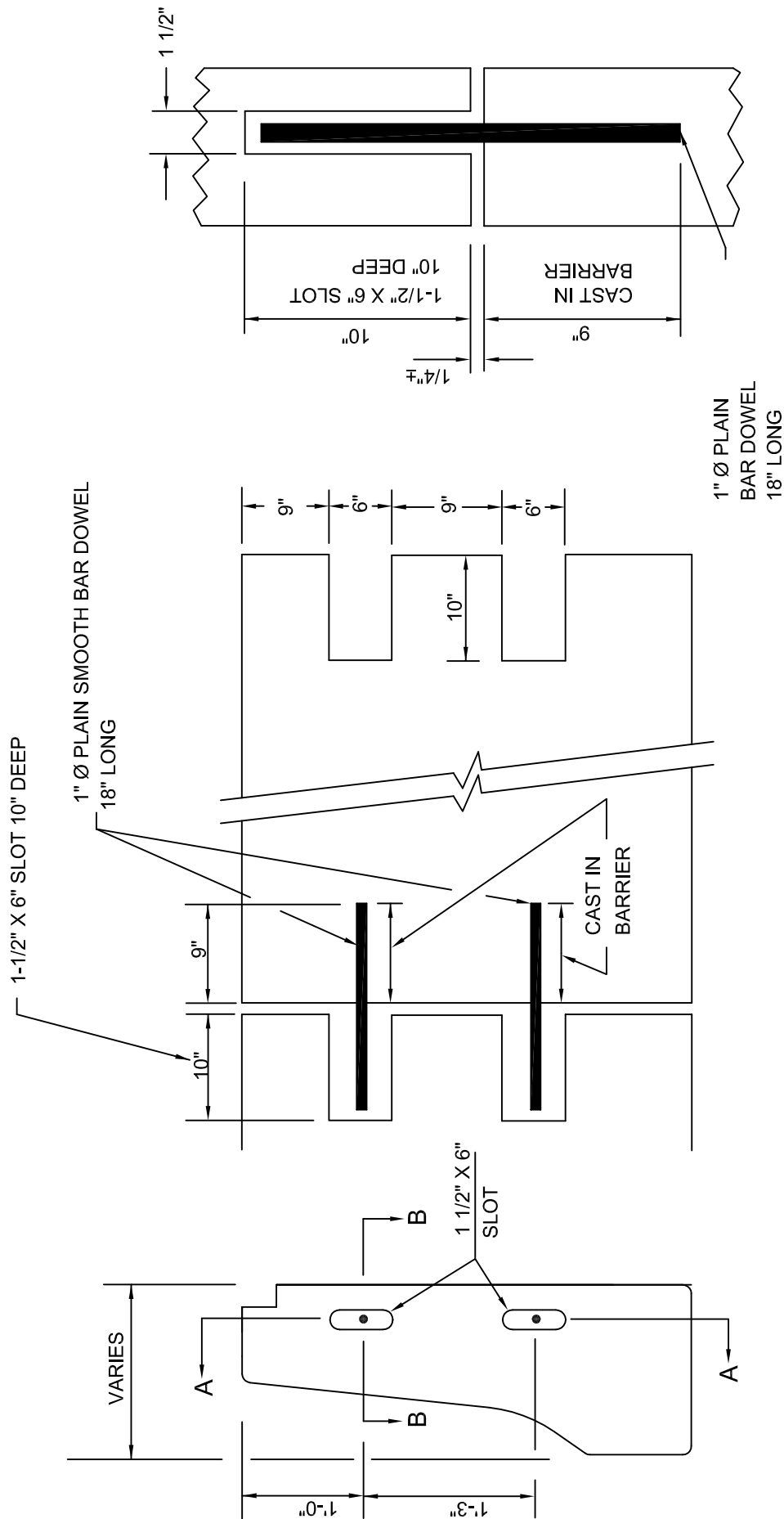
DATE OF ISSUE  
OCTOBER 2017

DRAWING NUMBER  
**E 402.21.0**

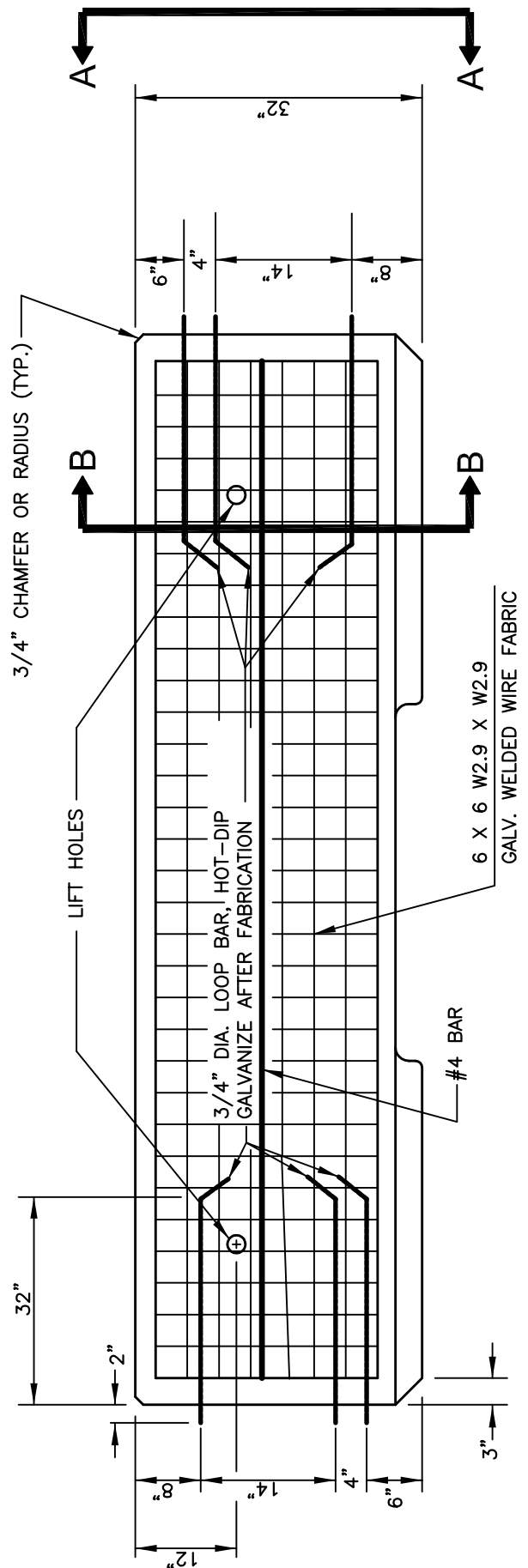
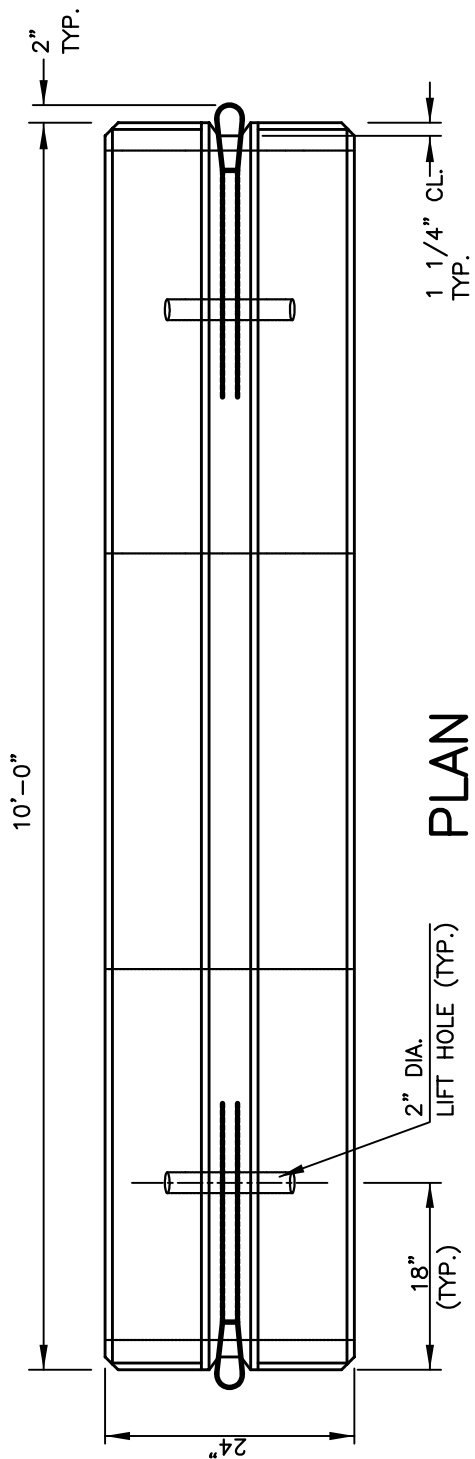


## NOTES:

1. ALL LONGITUDINAL BARS ARE TO BE CONTINUOUS FOR BOTH PRECAST BARRIERS AND CAST IN PLACE BARRIERS.
2. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
3. CAST IN PLACE (CIP) NOT TO EXCEED 200 FT BETWEEN EXPANSION JOINTS.
4. CONTRACTION JOINTS REQUIRED AT 40' INTERVALS (1/2" PREMOULDED JOINT FILLER REQUIRED FOR PRECAST BARRIERS).
5. ALL STEEL REINFORCING TO BE GALVANIZED OR EPOXY COATED, AASHTO-M31, GRADE 60.
6. FOR DIMENSIONS SEE E 401.20.0

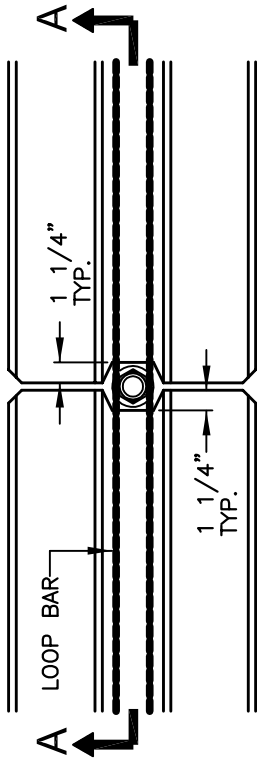


- NOTES:
1. DOWELS TO BE GALVANIZED, AASHTO M-31, GRADE 60.
  2. FOR ADDITIONAL DETAILS SEE E 402.20.0

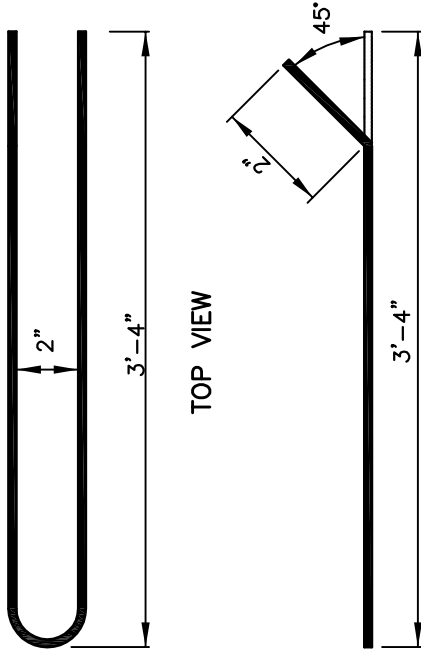








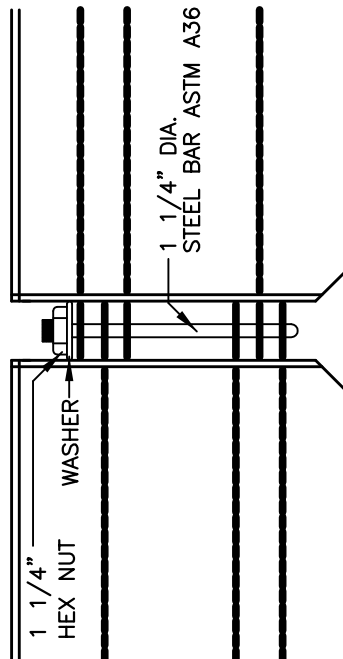
**PLAN OF CONNECTION**



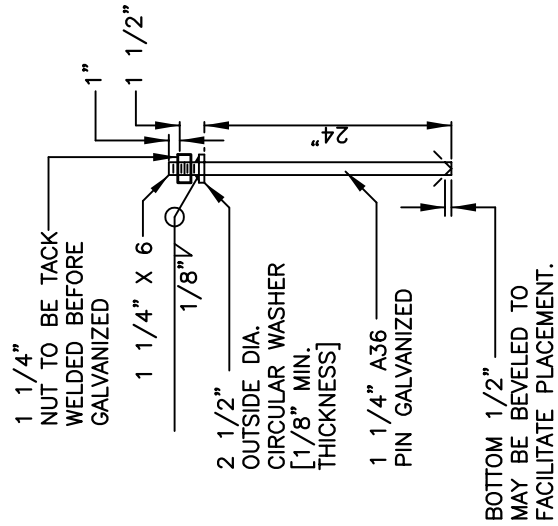
**TOP VIEW**

**SIDE VIEW  
LOOP BAR  
3/4" DIA. A36**

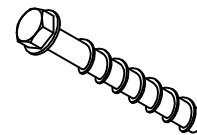
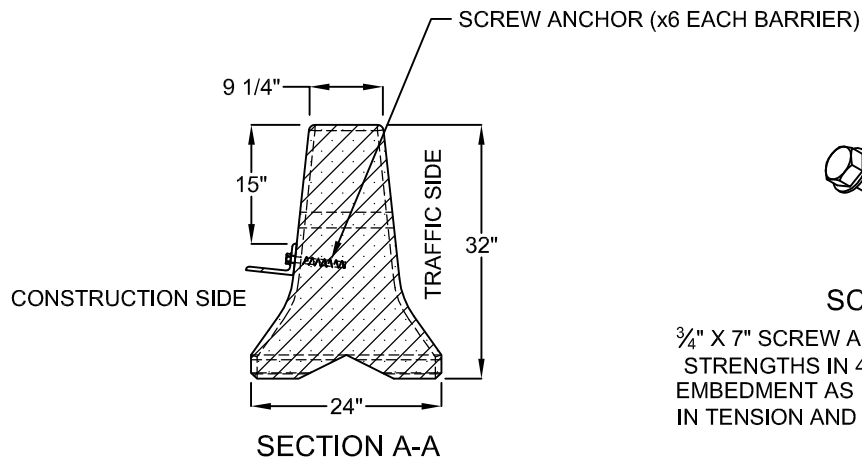
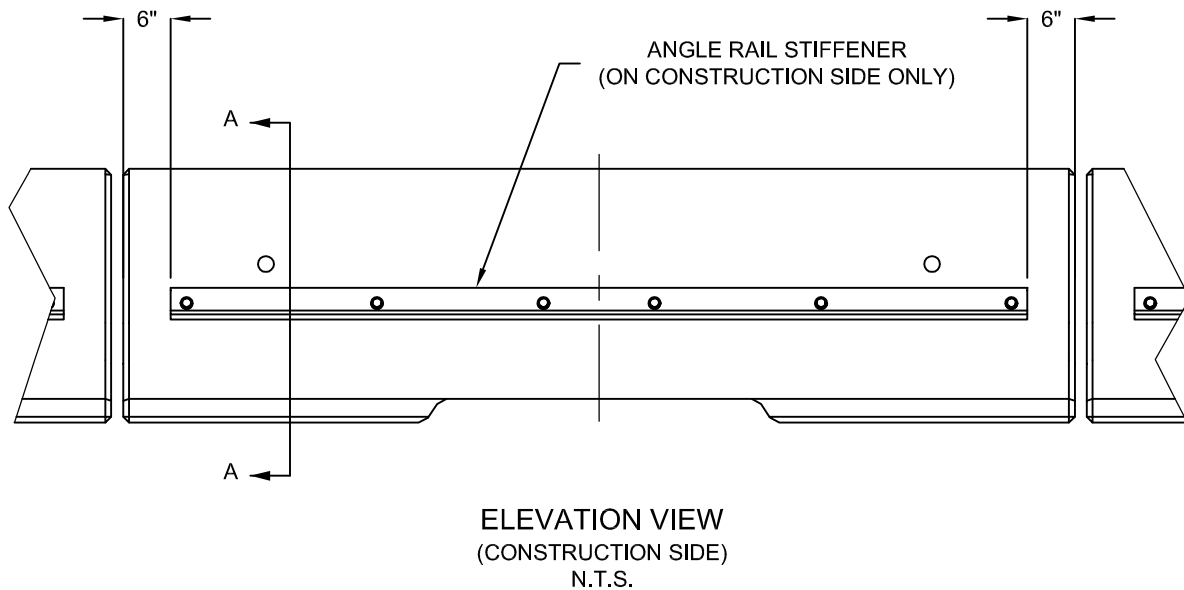
**REINFORCEMENT DETAIL**



**SECTION A-A**



**CONNECTOR PIN  
ASSEMBLY**



SCREW ANCHOR

3/4" X 7" SCREW ANCHOR WITH FACTORED DESIGN STRENGTHS IN 4,000 PSI CONCRETE WITH A 6 1/4" EMBEDMENT AS FOLLOWS: A MINIMUM 11,820 LBS IN TENSION AND A MINIMUM 25,455 LBS IN SHEAR.

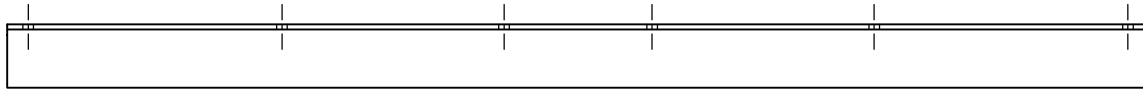
## TEST RESULTS

### MASH 3-11 ON CONCRETE:

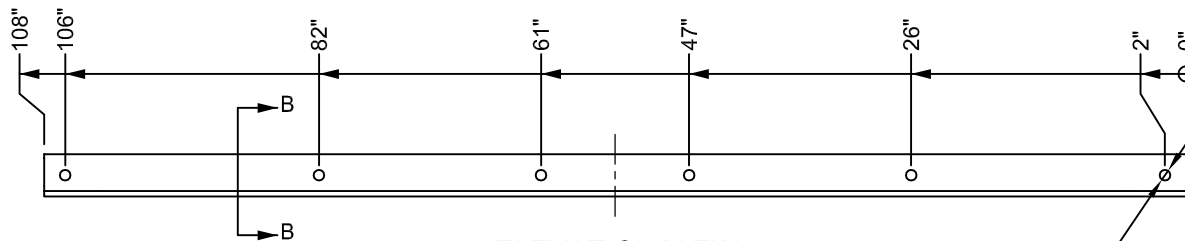
1. INSTALLATION LENGTH: 20 SEGMENTS
2. DYNAMIC DEFLECTION AT BASE: 59.0"
3. PERMANENT DEFLECTION AT BASE: 59.0"
4. WORKING WIDTH: 81.4"

## NOTES:

1. SEE MASSDOT DRAWING # E 403.2.0 FOR CONNECTION AND BARRIER DETAILS.
2. FOLLOW MANUFACTURER'S INSTRUCTION FOR INSTALLING SCREW ANCHORS.

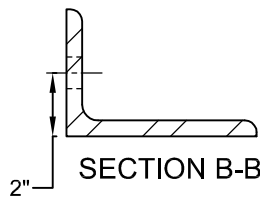


PLAN VIEW



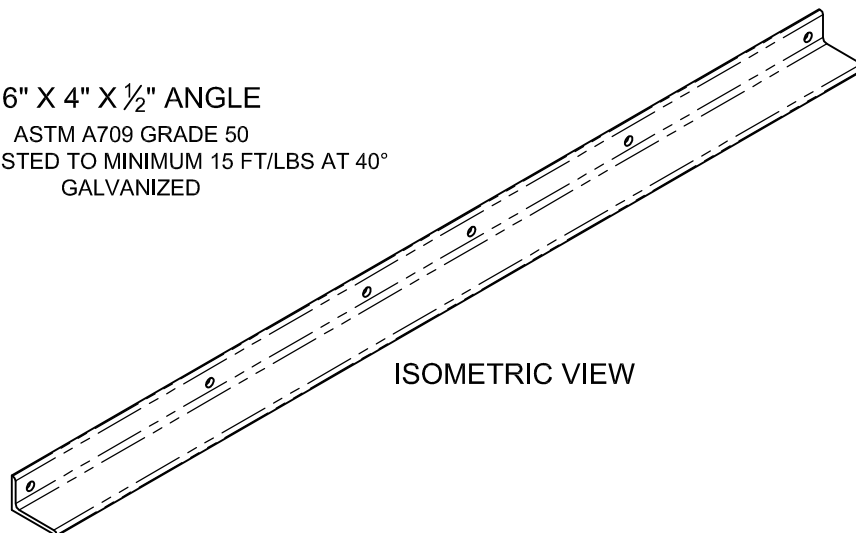
ELEVATION VIEW

Ø1" TYP x 6



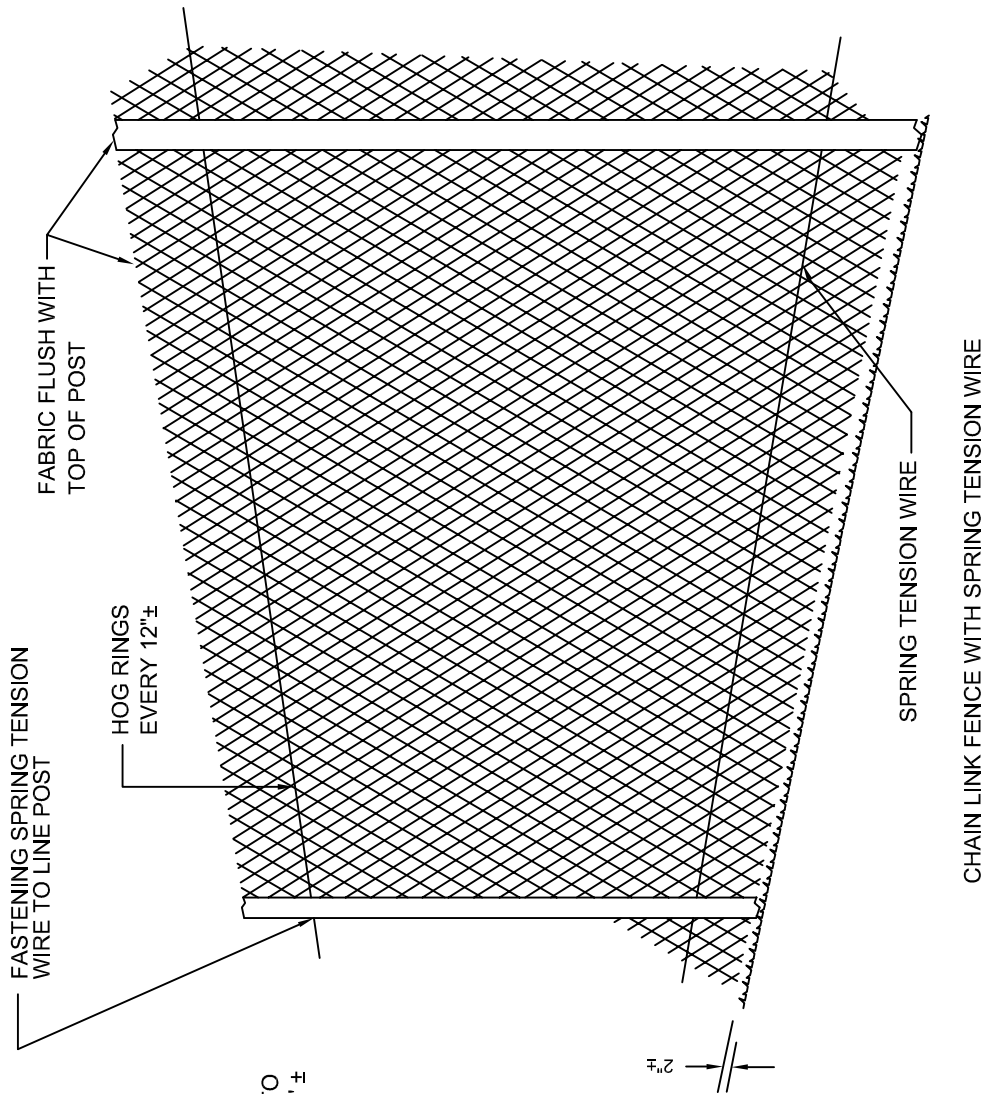
SECTION B-B

6" X 4" X ½" ANGLE  
ASTM A709 GRADE 50  
CHARPY TESTED TO MINIMUM 15 FT/LBS AT 40°  
GALVANIZED



ISOMETRIC VIEW

ANGLE DETAILS



LINE POSTS TO BE SPACED 10'-0" C. TO C. MAXIMUM EXCEPT ON CURVES WHERE THEY SHALL BE SPACED AS FOLLOWS:

CURVES 200' TO 500' RADIUS	8'-0" C. TO C. MAXIMUM
CURVES 100' TO 200' RADIUS	6'-0" C. TO C. MAXIMUM
CURVES LESS THAN 100' RADIUS	5'-0" C. TO C. MAXIMUM

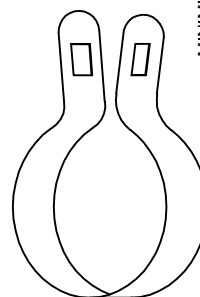
LINE POST SPACING



DRAWING NUMBER  
**E 404.2.0**



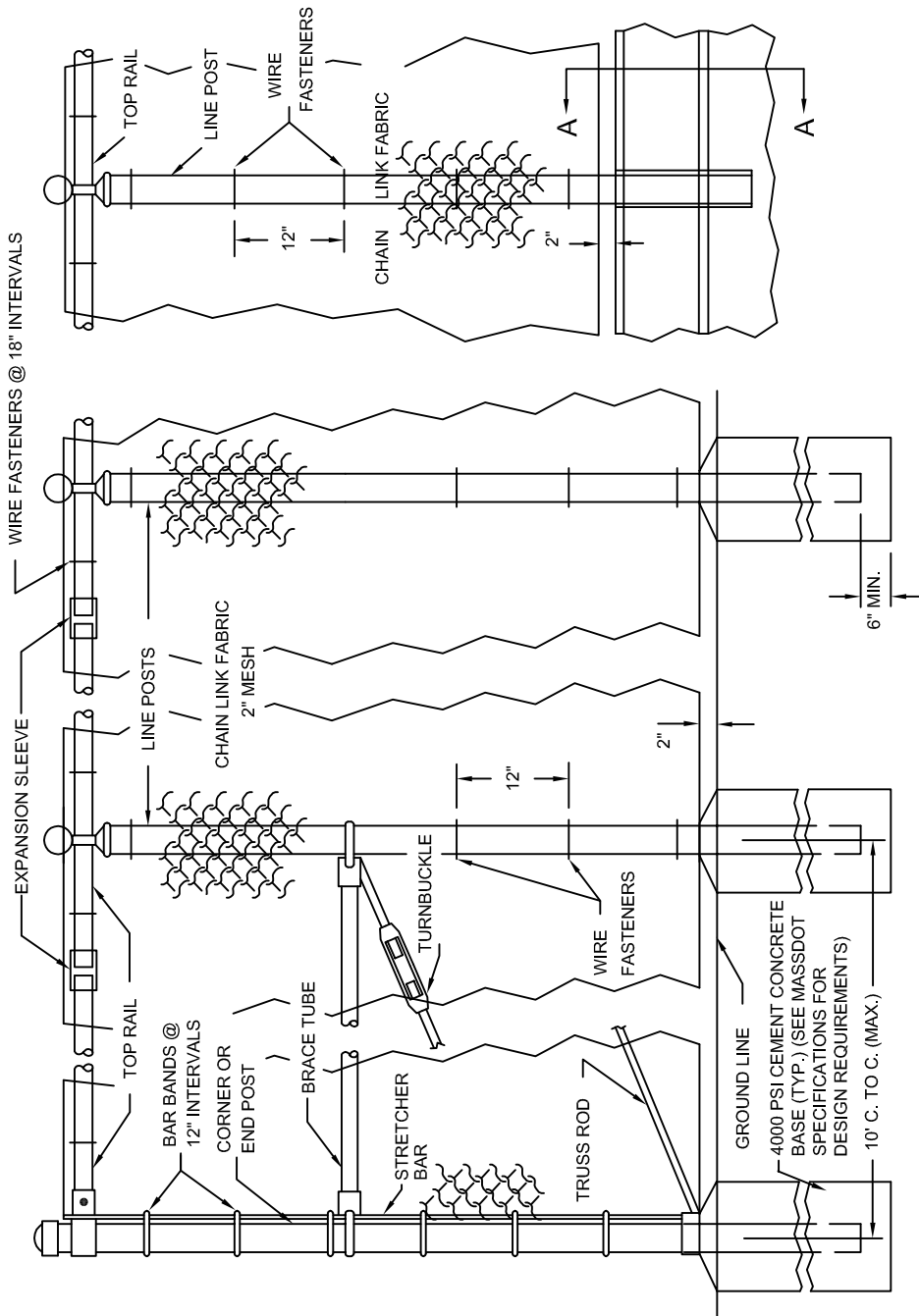
1. FABRIC FOR FENCES 4' OR LESS IN HEIGHT; TOP SELVAGE TO HAVE KNUCKLED FINISH; BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
2. FABRIC FOR FENCES 5' OR OVER IN HEIGHT; BOTH TOP AND BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
3. GRADE OF FENCE TO BE PARALLEL WITH THE GRADE OF SIDEWALKS, CURBING, GROUND OR TOP OF WALL.
4. INTERMEDIATE POST INTERVALS NOT TO EXCEED 500 FEET.
5. SPACING OF LINE POST ON CURVES, SEE DRAWING E 404.1.0
6. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS
7. SPRING TENSION WIRE TO BE FASTENED TO FABRIC WITH 11 GAUGE HOG RINGS AT 1' INTERVALS.
8. SPRING TENSION WIRE TO BE FASTENED TO LINE POSTS WITH CLIPS.
9. LINE POSTS TO BE DRIVEN EXCEPT WHERE NOTED ABOVE.



SPRING TENSION WIRE  
MINIMUM OF (5) TURNS AROUND THE  
SPRING TENSION WIRE TO END INSTANT  
ALL BANDS SHALL BE ROUNDED ON ROUNDED

END BAND

# CHAIN LINK FENCE (PIPE TOP RAIL)



FENCE ON GROUND

NOTES:

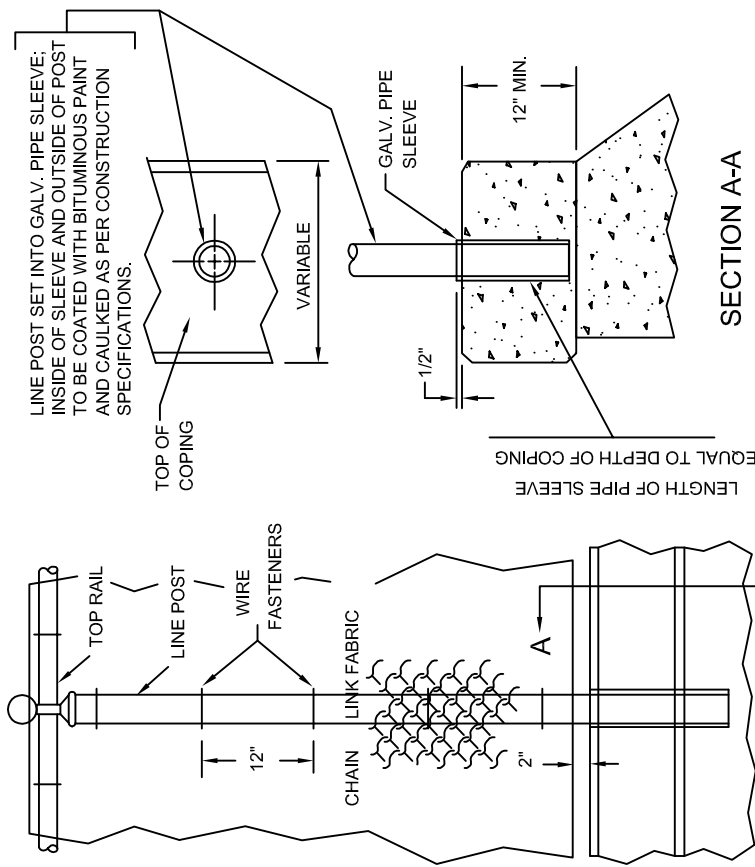
- FABRIC FOR FENCES 4' OR LESS IN HEIGHT. TOP SELVAGE TO HAVE KNUCKLED FINISH. BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED. FABRIC FOR FENCES 5' OR OVER IN HEIGHT. BOTH TOP AND BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
- THE HEIGHT OF FENCE TO BE AS SPECIFIED.
- GRADE OF FENCE TO BE PARALLEL WITH THE GRADE OF SIDEWALKS, CURBING, GROUND OR TOP OF WALL.

- LINE POSTS TO BE SPACED 10'-0" C. TO C. MAXIMUM EXCEPT ON CURVES WHERE THEY SHALL BE SPACED AS FOLLOWS:

- CURVES 200' TO 500' RADIUS 8'-0" C. TO C. MAXIMUM
- CURVES 100' TO 200' RADIUS 6'-0" C. TO C. MAXIMUM
- CURVES LESS THAN 100' RADIUS 5'-0" C. TO C. MAXIMUM

- FOR POST BASES AND CABLE ATTACHMENTS, SEE DRAWING E 404.5.0
- FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.

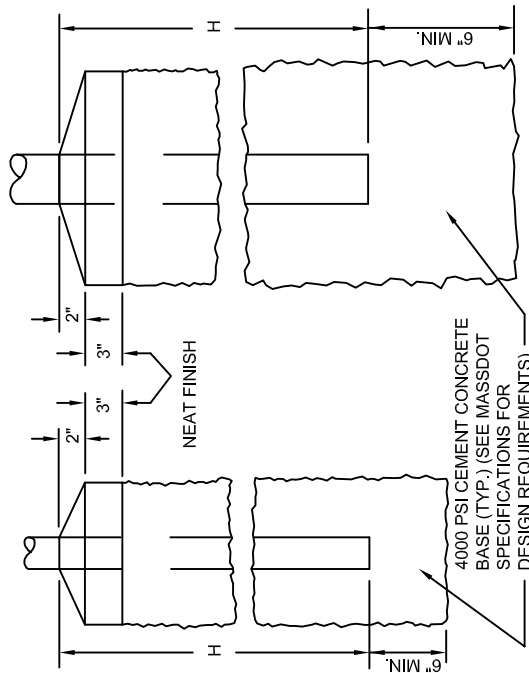
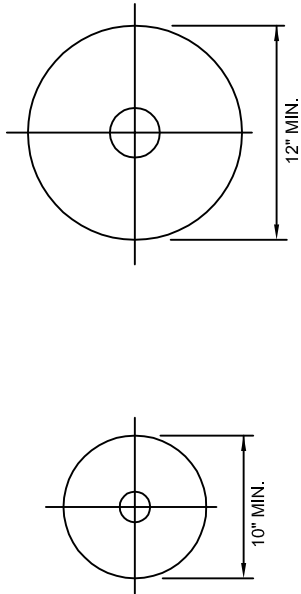
FENCE ON CONCRETE WALL



SECTION A-A

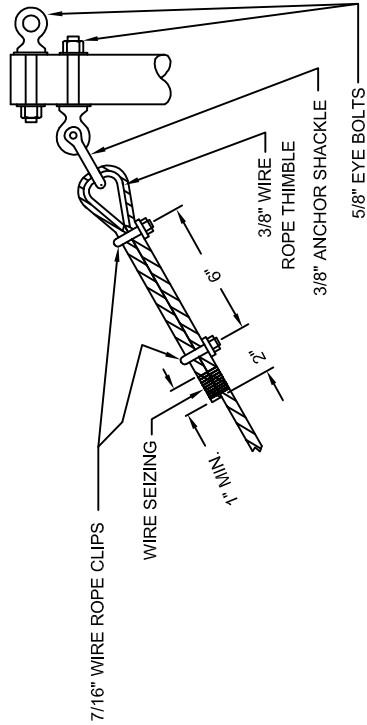
# CHAIN LINK FENCE DETAILS OF CABLE ATTACHMENTS AND POST BASES

## POST BASES

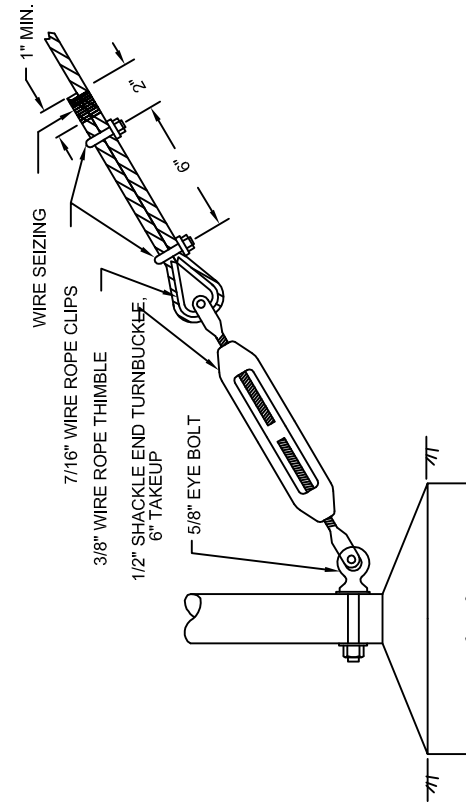


## FOR CORNER, END LINE AND PULL POSTS FOR GATE POSTS

FENCE HEIGHT	MIN. H
5' OR LESS	2'-6"
OVER 5'	3'-0"



## FOR END PULL POST

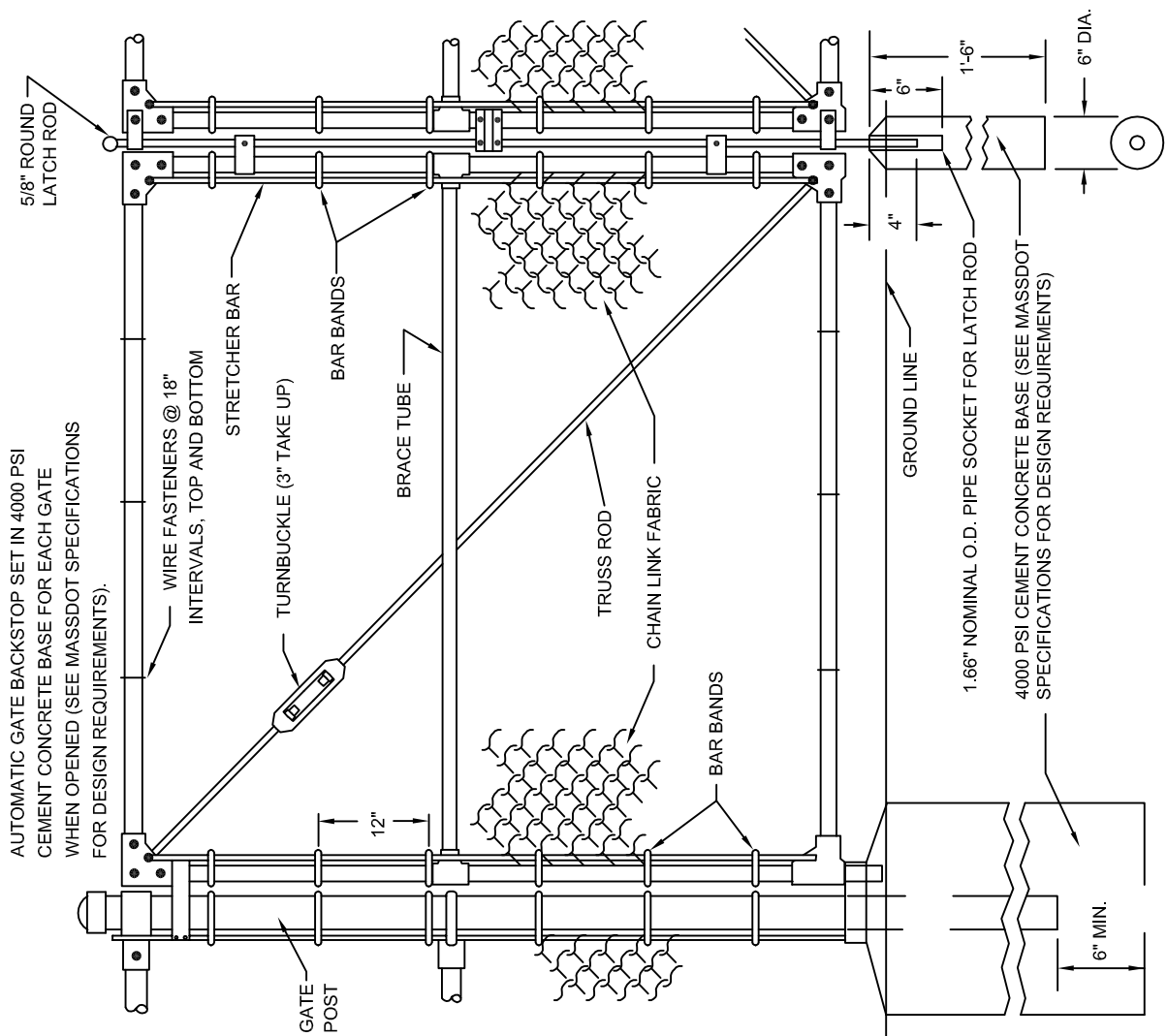


## FOR FASTENING TO BASE OF POST

NOTE:  
1. FOR EYE BOLT INSTALLATION THROUGH PIPE SECTIONS, USE  
2 WASHERS ON "SHOULDER SIDE" AND 1 WASHER WITH LOCK  
WASHER ON "NUT SIDE" OF POSTS.

## DETAILS OF CABLE ATTACHMENTS





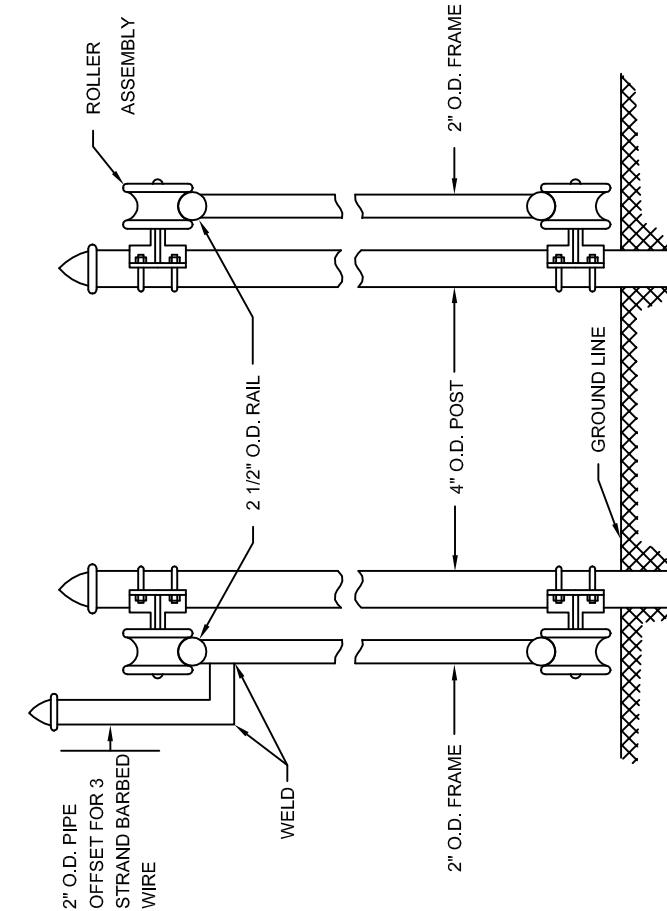
END POSTS TO BE USED ON LATCH SIDE OF SINGLE GATE OPENINGS.

1. CHAIN LINK FABRIC FOR GATES TO BE THE SAME AS REQUIRED FOR FENCE.

2. FOR GATE POST BASE, SEE DRAWING 404.5.0

DOUBLE GATES

# CHAIN LINK FENCE CANTILEVER GATE



WHEEL EQUIPPED WITH ROLLER BEARINGS  
AND LUBRICATION FITTING.  
MASSIVE MALLEABLE CONSTRUCTION.  
4 ASSEMBLIES NEEDED PER SECTION.

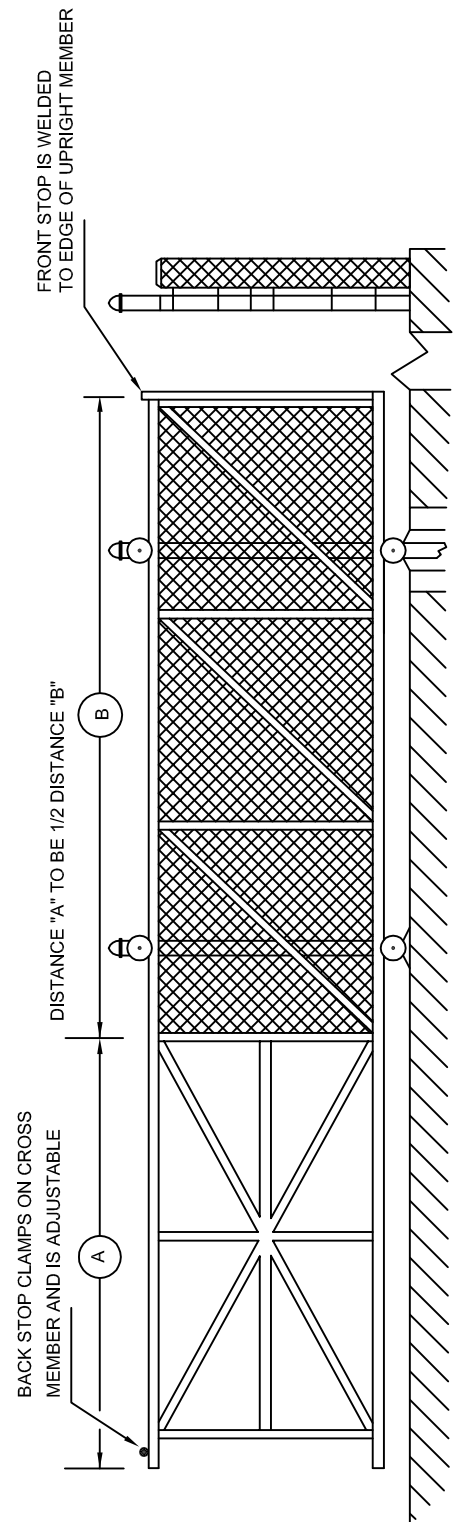
ROLLER ASSEMBLY

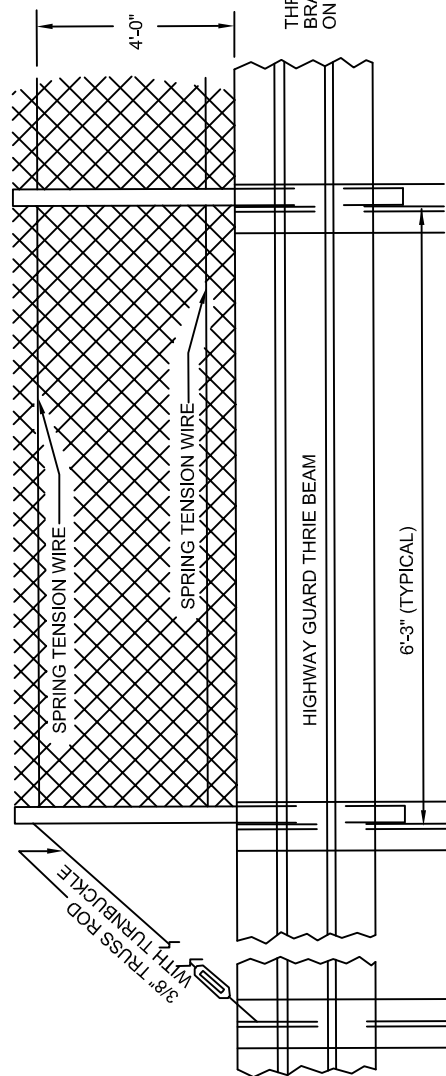
LATCH AND LOCKING  
ASSEMBLY

## SPECIFICATIONS OF GATE FRAME

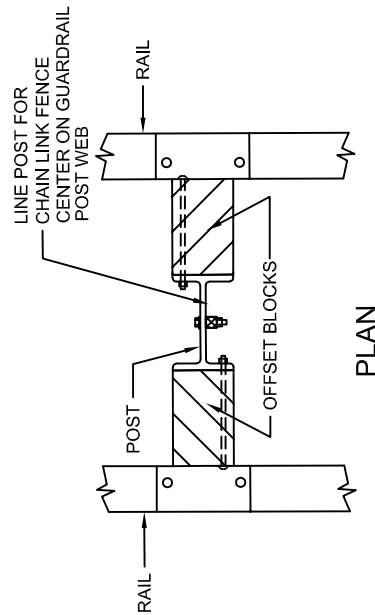
TOP AND BOTTOM MEMBER----- 2 1/2" O.D. PIPE  
UPRIGHT MEMBERS----- 2" O.D. PIPE  
HORIZONTAL AND DIAGONAL BRACES----- 1 5/8" O.D. PIPE

## SIDE VIEW SHOWING TRUSS TYPE CONSTRUCTION





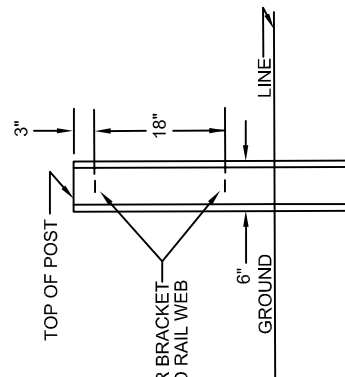
## CHAIN LINK FENCE POST



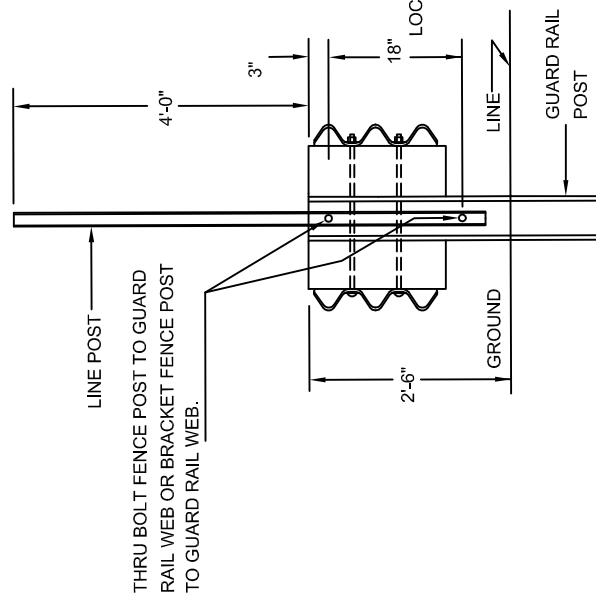
## PLAN

## NOTES:

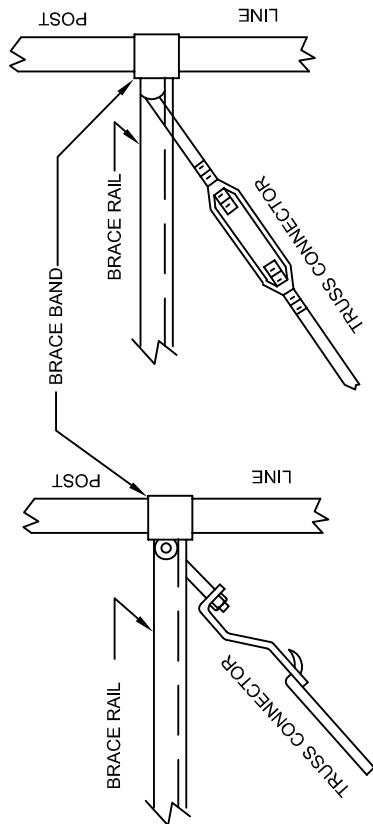
1. ALL POSTS (LINE, END, AND INTERMEDIATE) SHALL CONFORM TO DETAILS SHOWN ON DRAWING E 404.1.0
2. END BRACING TO CONFORM TO DETAIL SHOWN ABOVE. INTERMEDIATE BRACING SHALL BE IN CONFORMANCE TO DETAILS SHOWN ON DRAWING E 404.2.0
3. FOR DESCRIPTION, MATERIALS AND METHODS, SEE STANDARD SPECIFICATIONS.
4. SHALL USE A ROUND OR C FENCE POST



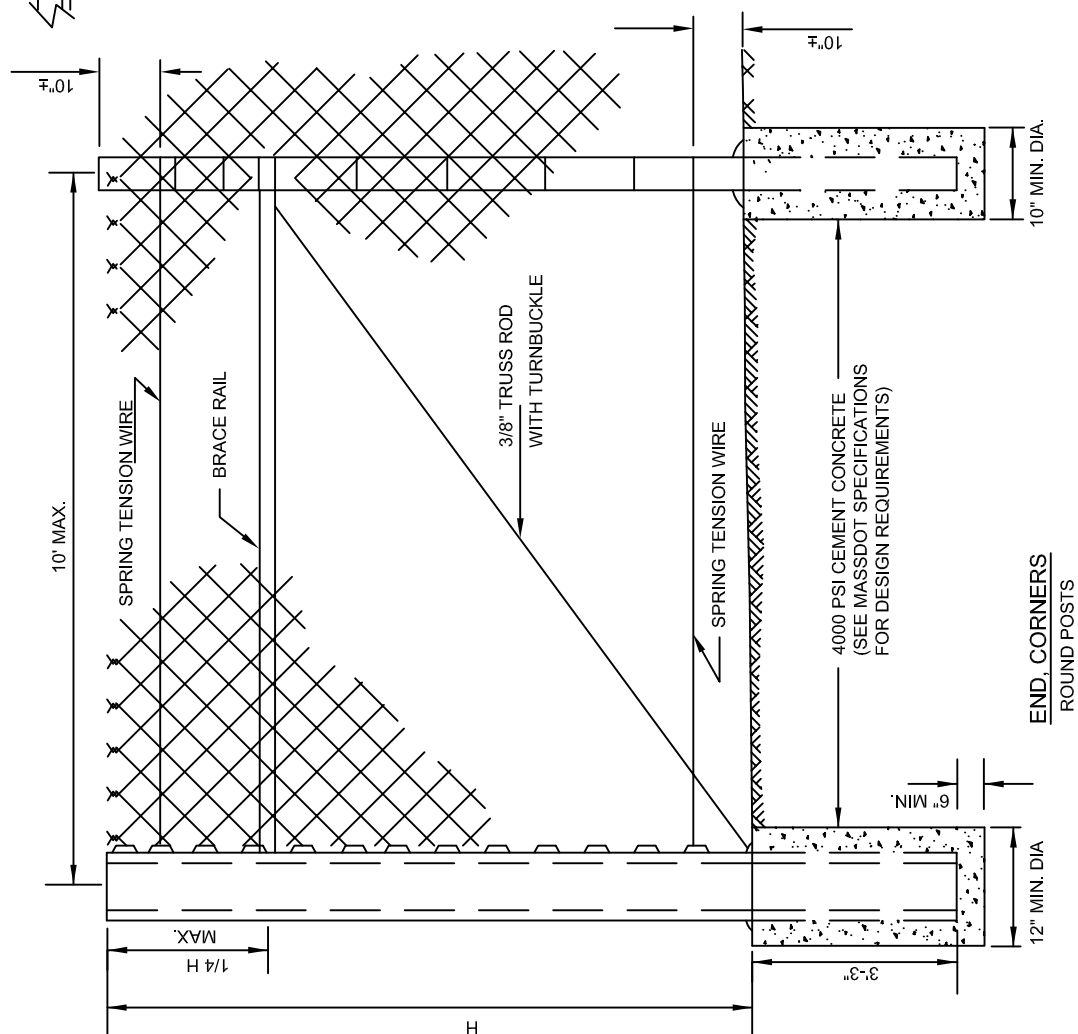
G.R. POST



## ELEVATION

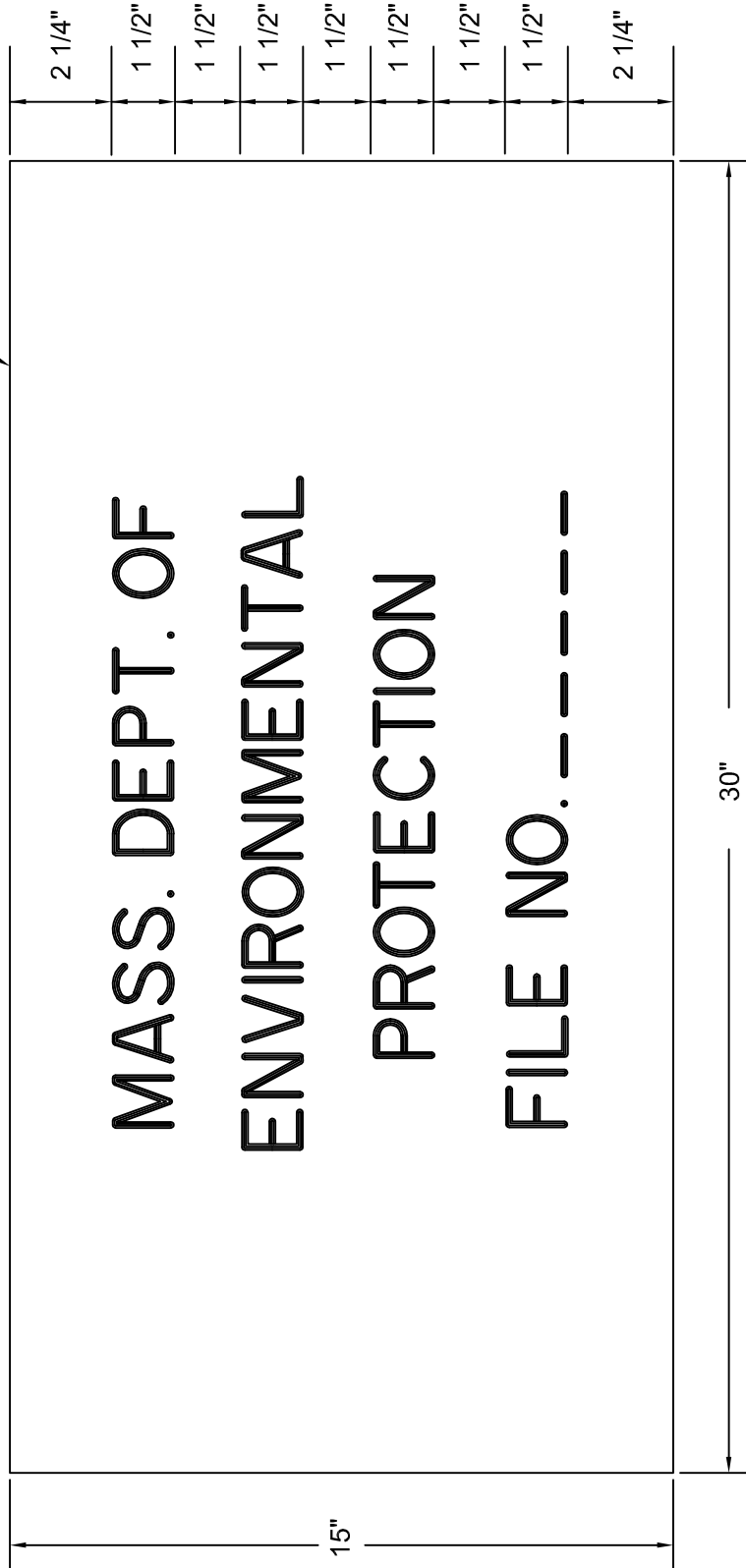


BRACE & TRUSS CONNECTIONS



# WETLANDS PROTECTION ACT SIGN

0.080" SHEET ALUMINUM



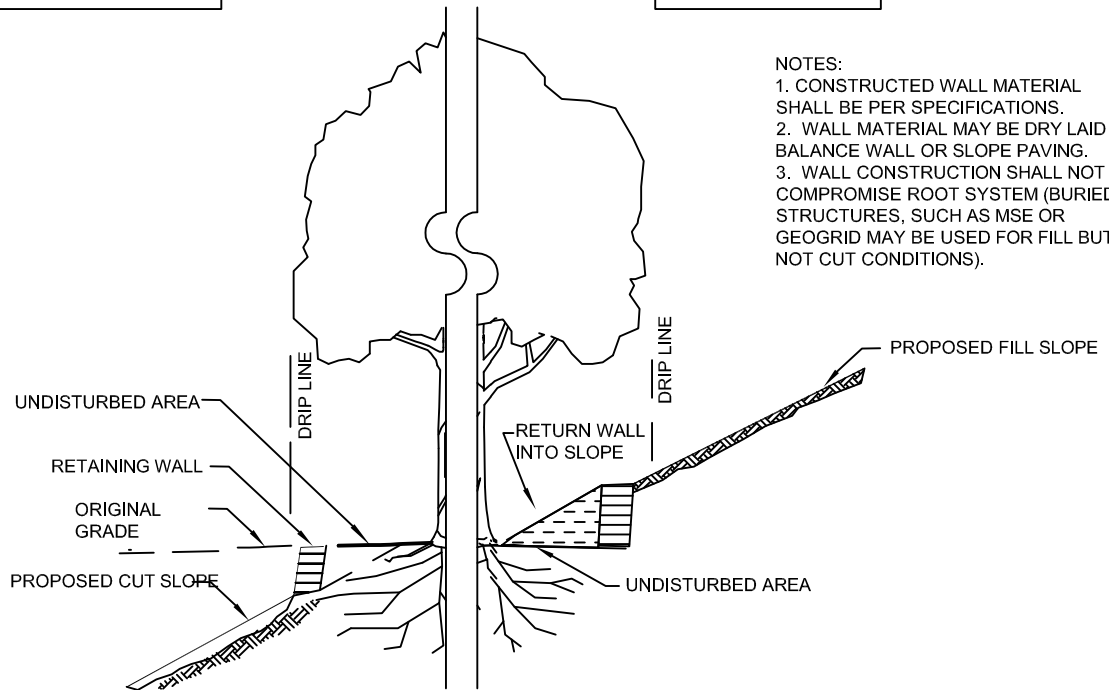
COLORS ——— LEGEND - BLACK (NON-REFLECTORIZED)  
BACKGROUND - WHITE (REFLECTORIZED)

THE SIGN IS TO BE MOUNTED ON A MASSDOT  
HIGHWAY DIVISION STANDARD "P-5" POST

- NOTES:
1. THE SIGN IS PLACED ON ALL PROJECTS SUBJECT TO THE PROVISIONS OF THE MASSACHUSETTS WETLANDS PROTECTION ACT.
  2. THE LOCATION OF THE SIGN IS TO BE DETERMINED BY THE ENGINEER.
  3. SEE SPECIAL PROVISIONS FOR THE MANUFACTURE, MAINTENANCE, ERECTION AND REMOVAL RESPONSIBILITIES.
  4. USE SERIES "D" FOR LETTERING.

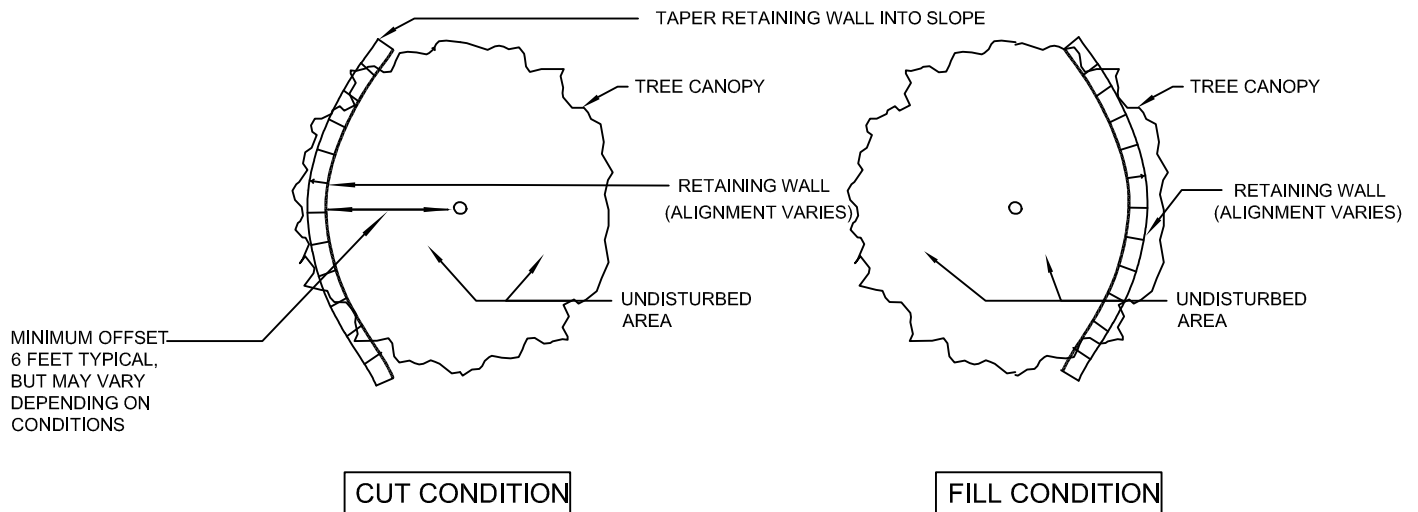
CUT CONDITION

FILL CONDITION

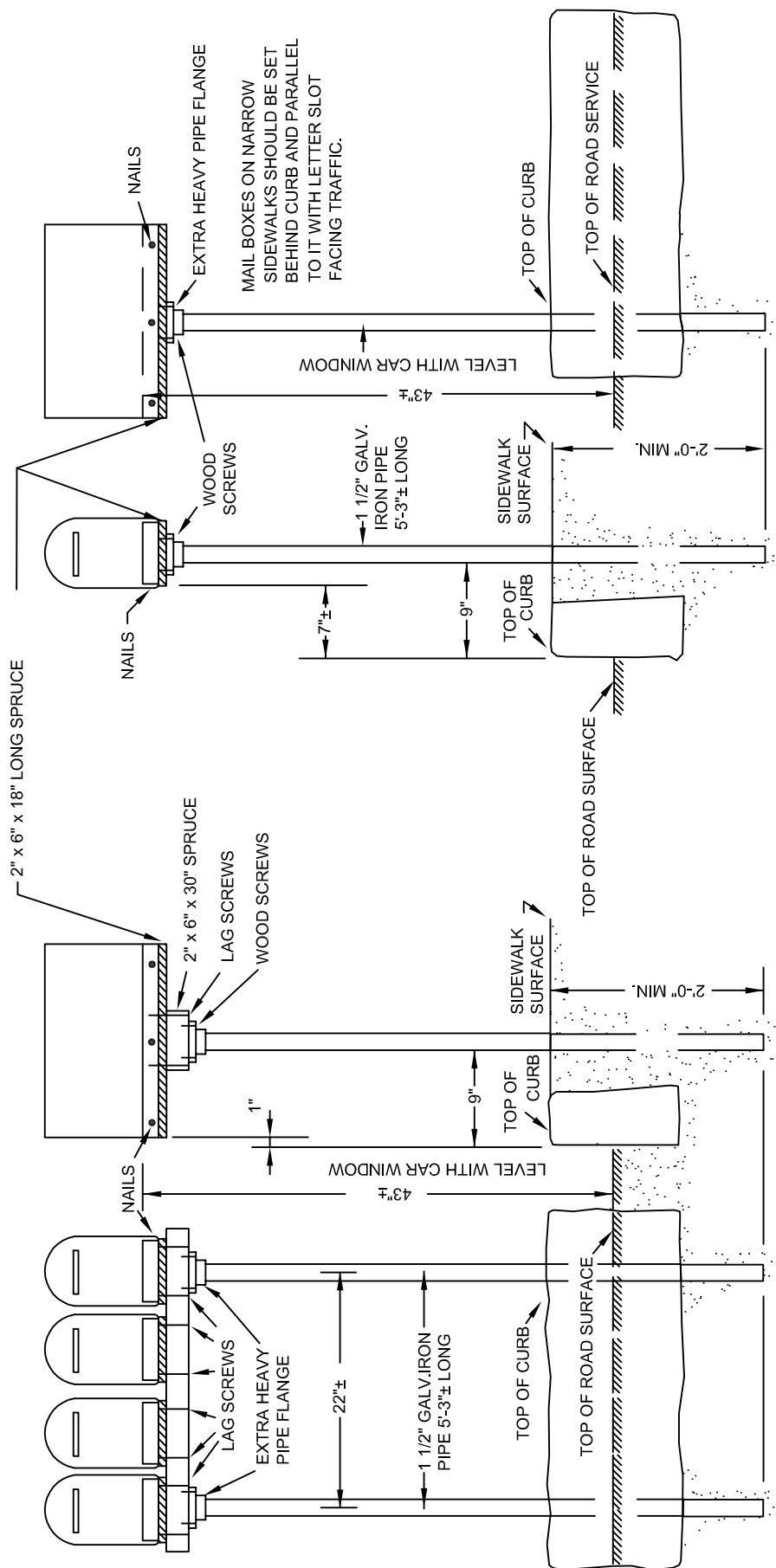


- NOTES:
1. CONSTRUCTED WALL MATERIAL SHALL BE PER SPECIFICATIONS.
  2. WALL MATERIAL MAY BE DRY LAID BALANCE WALL OR SLOPE PAVING.
  3. WALL CONSTRUCTION SHALL NOT COMPROMISE ROOT SYSTEM (BURIED STRUCTURES, SUCH AS MSE OR GEOGRID MAY BE USED FOR FILL BUT NOT CUT CONDITIONS).

## SECTION VIEW



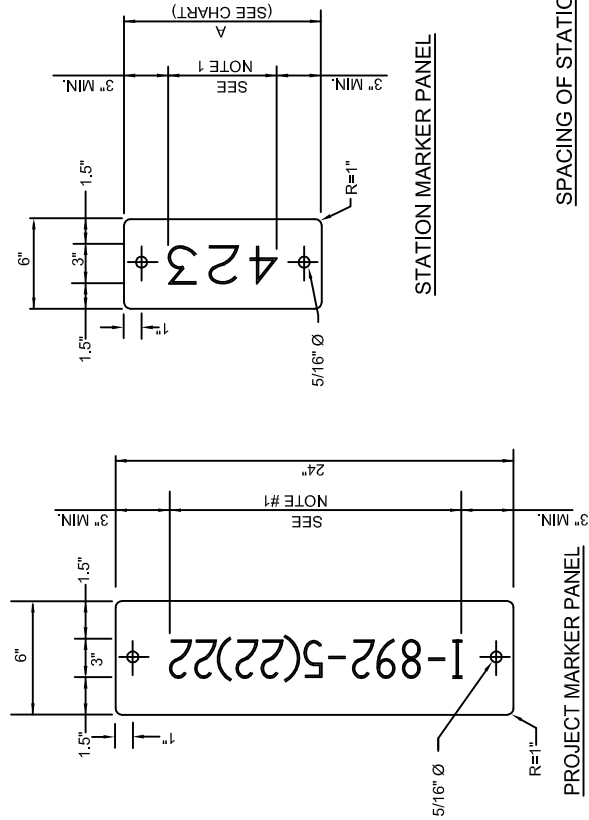
## PLAN VIEW



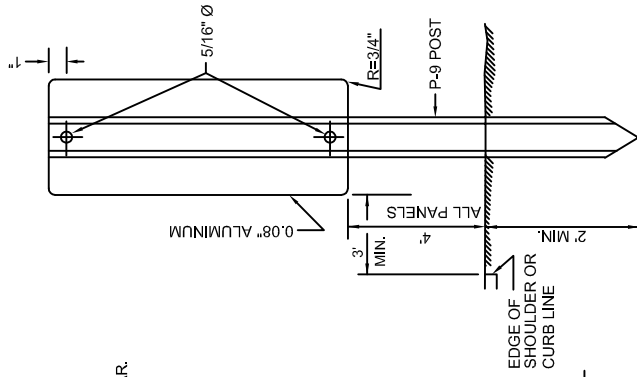
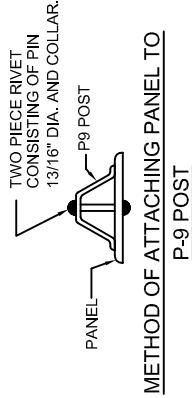
**NOTES:**

1. LUMBER TO BE PLANED ON ALL FOUR SIDES TO FULL 2" x 6" SIZE TO FIT BOTTOM OF MAIL BOXES.
2. TO SET 1 1/2" GALVANIZED PIPE POST, USE DRIVING POINT OF SAME SIZE, THEN TAMP POST INTO PLACE SO AS TO BE PLUMB BOTH WAYS.
3. ALL FITTINGS (PIPE FLANGES, PIPE, SCREWS, NAILS, ETC.) ARE TO BE GALVANIZED.
4. FOR DESCRIPTIONS, MATERIALS, AND CONSTRUCTIONS METHODS SEE STANDARD SPECIFICATIONS.
5. A 4" x 4" PRESSURE TREATED WOOD POST MAY BE SUBSTITUTED FOR A PIPE POST.

# DEMOUNTABLE REFLECTORIZED STATION MARKER AND PROJECT MARKER

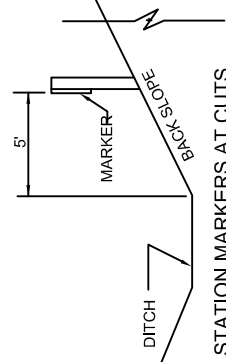
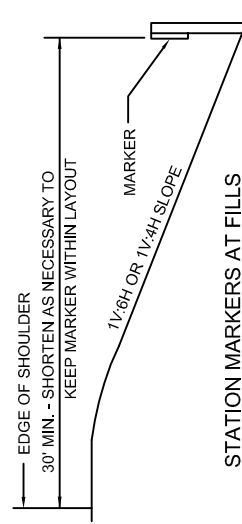
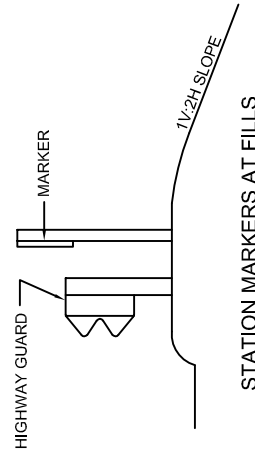
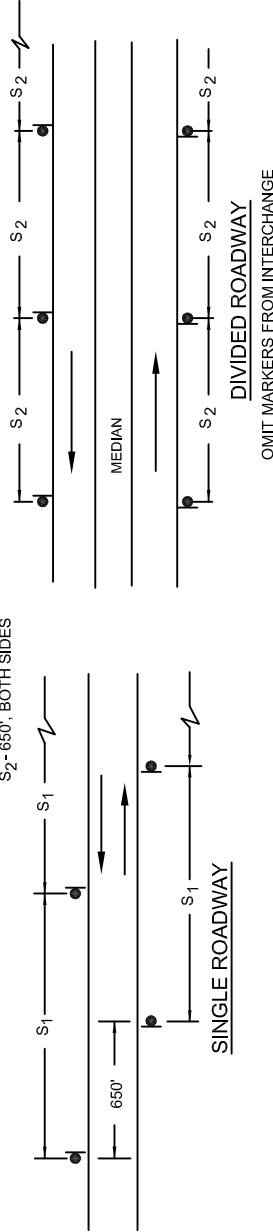


# OF DIGITS	A Inches
1	8
2	11
3	13



## SPACING OF STATION NUMBERS

S<sub>1</sub> - 1300', BOTH SIDES, STAGGER  
S<sub>2</sub> - 650', BOTH SIDES



## NOTES:

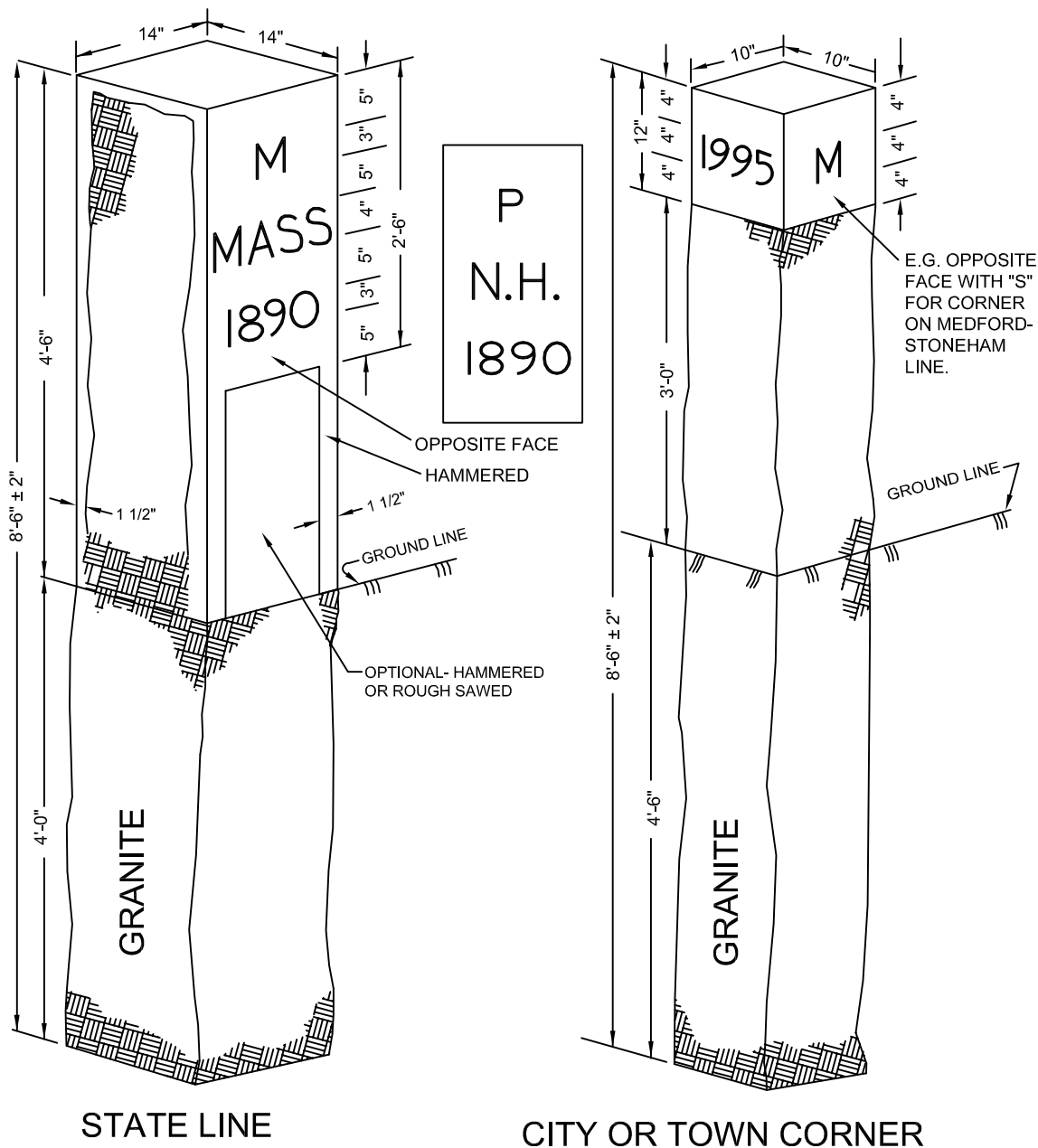
1. THE LEGEND IS TO BE CENTERED AND THE SPACING OF THE CHARACTERS IS TO CONFORM TO THE FEDERAL HIGHWAY ADMINISTRATION RECOMMENDATION FOR SERIES "C" TYPE LETTERING.
2. THE STATION DESIGNATIONS ARE TO BE EVEN STATIONS I.E. NO PLUS STATIONS.
3. THE PANELS FOR THE LEGEND ARE TO BE 0.08" SHEET ALUMINUM. FABRICATED AND FINISHED ACCORDING TO THE STANDARD SPECIFICATIONS.
4. THE LETTERS AND NUMERALS AND METHOD OF APPLICATIONS ARE DESCRIBED IN THE STANDARD SPECIFICATIONS.
5. ALL PANELS ARE TO BE MOUNTED ON NEW P-9 POST IN THE MANNER DESCRIBED IN THE STANDARD SPECIFICATIONS.
6. ONE MARKER IS TO BE PROVIDED AT CULVERT END, WHERE NO GUARD RAIL IS INSTALLED IT IS TO BE LOCATED AT THE NEAR BACK CORNER OF THE END IN THE DIRECTION OF TRAFFIC.
7. MARKERS ARE TO BE PLACED AT 650' INTERVALS; ON UNDIVIDED ROADWAY STAGGER ON EACH SIDE, ON DIVIDED ROADWAY PLACE MARKERS OPPOSITE EACH OTHER.
8. SEE DRAWING E TR.2.3 FOR P-9 POST DIMENSIONS.



REPLACEMENT OF BOUND BROKEN OR LOST WILL BE INSCRIBED WITH THE YEAR BOUND POINT WAS ESTABLISHED.

BOUNDS LOCATING NEW CORNERS WILL BE INSCRIBED WITH THE YEAR NEW CORNER WAS ESTABLISHED.

ALL LETTERING TO BE  
1/2" V SUNK LETTERS



NOTES:

1. TOP AND 4 SIDES FOR A DISTANCE OF 12" TO BE HAMMERED SMOOTH.
2. IN SPECIFIED LOCATIONS, MONUMENTS MAY BE HAMMERED SMOOTH ON TOP AND 4 SIDES ABOVE GROUND LINE.
3. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS SEE STANDARD SPECIFICATIONS.